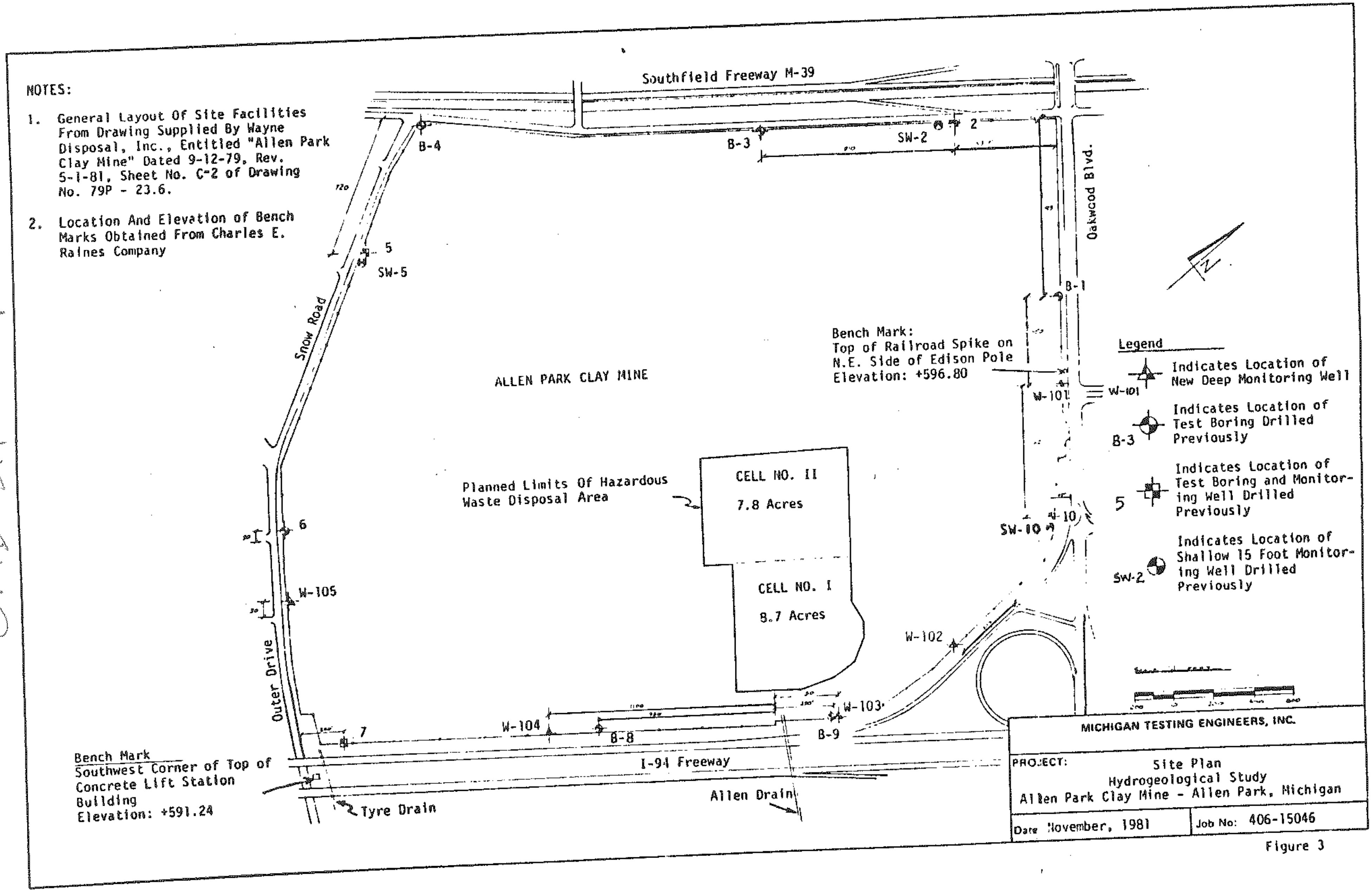
CME Site Map


NOTES:
1. General Layout Of Site Facilities From Drawing Supplied By Wayne Disposal, Inc., Entitled "Allen Park Clay Mine" Dated 9-12-79, Rev. 5-1-81, Sheet No. C-2 of Drawing No. 79P - 23.6.
2. Location And Elevation of Bench Marks Obtained From Charles E. Raines Company
Southfield Freeway M-39
B-4
B-3
SW-2
2
Oakwood Blvd.
Snow Road
5
SW-5
B-1
Bench Mark:
Top of Railroad Spike on N.E. Side of Edison Pole
Elevation: +596.80
ALLEN PARK CLAY MINE
W-101
Legend
Indicates Location of New Deep Monitoring Well
Indicates Location of Test Boring Drilled Previously
Indicates Location of Test Boring and Monitoring Well Drilled Previously
Indicates Location of Shallow 15 Foot Monitoring Well Drilled Previously
Planned Limits Of Hazardous Waste Disposal Area
CELL NO. II
7.8 Acres
CELL NO. I
8.7 Acres
6
W-105
Outer Drive
SW-10
10
W-102
W-103
W-104
7
B-8
B-9
Bench Mark
Southwest Corner of Top of Concrete Lift Station Building
Elevation: +591.24
I-94 Freeway
Allen Drain
Tyre Drain
MICHIGAN TESTING ENGINEERS, INC.
PROJECT: Site Plan
Hydrogeological Study
Allen Park Clay Mine - Allen Park, Michigan
Date November, 1981
Job No: 406-15046
Figure 3

Pefer

XC: BEN/DE

ORIG: MOR/FORD ALLEN PARK

Dave → Terry

Ford Motor Company

3001 Miller Road
Dearborn, Michigan 48121

29 February 1988

U. S. Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, Illinois 60604

Attention: 5HE - 12

Subject: Annual Groundwater Monitoring Report
Ford Allen Park Clay Mine
EPA I.D. No. MID 980 568 711

The enclosed groundwater monitoring data are submitted in accordance with the reporting requirements of 40 CFR 265.94 for the subject facility.

The monitoring plan requested by William E. Muno, Chief of the RCRA Enforcement Section, in his November 27, 1985 letter is one of annual sampling and static water level measurements of upgradient wells 5-D and 5-S, and downgradient wells 2-D, 2-S, 102-D, 103-D and 104-D. The waste-specific parameters to be analyzed are: cadmium, cyanide (complexed), hexavalent chromium, lead, naphthalene, nickel, and phenol. As stated in the Allen Park Clay Mine groundwater waiver demonstration submitted in 1985, the monitoring program in place is unfounded in detecting the migration of hazardous constituents from the site. Therefore, we conclude that the enclosed data do not reflect activities associated with the Allen Park Clay Mine Hazardous Waste Landfill.

All requested information is attached with the exception of shallow well 5-S. Samples obtained from shallow well 5-S have been submitted for analysis. Laboratory results are expected within the month and will be forwarded to you under separate cover. Please note that upon bailing shallow well 2-S, there was insufficient recharge after twenty-five hours to obtain a sample; this well has a prior history of recharging slowly.

Very truly yours,

Douglas A. Painter

Douglas A. Painter, Manager
Mining Department

RECEIVED
MAR 1 1988
Waste Management Division

DAP/dao

Attachment

ALLEN PARK CLAY MINE
Groundwater Monitoring Data Sheet
EPA Annual Requirements

Sampling Date: 11-24-87

Time of Sample Collection: ____________

Person(s) Collecting Sample: J. Bolin, J. Collins and B. Biesner

Laboratory Conducting Analysis: Burmah Technical Services, Inc.

WELL No. 5 Deep   QMR DESIGNATION H07U

I. Well Data USGS Coordinates

Casing Elevation 596.14'
Casing Material Galvanized Steel
Casing Depth 516.70

Casing Diameter 2"
Pressure Reading in inches of H_2O + 7.70'

STATIC WATER ELEVATION(ft) 603.84' Taken on 11-23-87 Time ________

II. Well Bailing Data

Device Used: Self bailing device
Material of Construction: Stainless steel with silicon stopper.
Time of Well Purging: Start/Date __________ Stop/Date __________
Flow Rate: __________ mls/minute Gallons Purged: Free Flow Overnight

III. Sampling Data

Significant Weather Conditions: ____________
Sample Equipment: Direct discharge from purging device.

Annual Sample Parameters

Parameters	Container	Preservative	Analytical Results
Cadmium			<0.01 mg/l
Lead	Plastic	HNO_3 to pH <2	<0.05
Nickel			<0.02
Hex Chromium	Plastic	Cool to 4°C	<0.05
Total Cyanide	Plastic	NaOH to pH >12	<0.02
Naphthalene	Glass	Cool to 4°C	0.018
Phenol	Glass	H_2SO_4 to pH <2	<0.01

IV. Field Analytical Data (Optional)

pH ________ Specific Conductivity ________ Temp ________

Appearance of Samples: ____________
Misc. Notes: ____________

ALLEN PARK CLAY MINE
Groundwater Monitoring Data Sheet
EPA Annual Requirements

Sampling Date: 2-26-88

Time of Sample Collection: 10:30 am

Person(s) Collecting Sample: Ed Chraszcz

Laboratory Conducting Analysis: Burmah Technical Services, Inc.

WELL No. 2 Shallow   QMR DESIGNATION A02U

I. Well Data USGS Coordinates

Casing Elevation 595.66'
Casing Material Galvanized Steel
Casing Depth 578.33
Casing Diameter 2"
Water Level -11.95'

STATIC WATER ELEVATION(ft) 583.71' Taken on 2-25-88 Time 09:30

II. Well Bailing Data

Device Used: Bailer
Material of Construction: PVC
Time of Well Bailing: 09:35 Date 2-25-88
Gallons Purged: To Dryness

III. Sampling Data

Significant Weather Conditions: Clear and Cold
Sample Equipment: Bailer

Annual Sample Parameters

Parameters	Container	Preservative	Analytical Results
Cadmium			No Sample mg/l
Lead	Plastic	HNO_3 to pH <2	NS
Nickel			NS
Hex Chromium	Plastic	Cool to 4°C	NS
Total Cyanide	Plastic	NaOH to pH >12	NS
Naphthalene	Glass	Cool to 4°C	NS
Phenol	Glass	H_2SO_4 to pH <2	NS

IV. Field Analytical Data (Optional)

pH ________ Specific Conductivity ________ Temp ________

Appearance of Samples: ________

Misc. Notes: Well dry 25 hours after bailing

ALLEN PARK CLAY MINE
Groundwater Monitoring Data Sheet
EPA Annual Requirements

Sampling Date: 11-24-87

Time of Sample Collection: ______________

Person(s) Collecting Sample: J. Bulin, J. Collins and B. Biesner

Laboratory Conducting Analysis: Burmah Technical Services, Inc.

WELL No. 2 Deep　　　　OMR DESIGNATION G06U

I. Well Data USGS Coordinates

Casing Elevation 600.76'　　　　Casing Diameter 2"
Casing Material PVC　　　　Water Level -0.5'
Casing Depth 518.10

STATIC WATER ELEVATION(ft) 600.26' Taken on 11-23-87 Time______

II. Well Bailing Data

Device Used: Bailer
Material of Construction: PVC
Time of Well Bailing: ____________ Date __________
Gallons Purged: 16.0 (Dry)

III. Sampling Data

Significant Weather Conditions: ______________
Sample Equipment: Bailer

Annual Sample Parameters

Parameters	Container	Preservative	Analytical Results
Cadmium			< 0.01 mg/l
Lead	Plastic	HNO_3 to pH <2	0.08
Nickel			< 0.02
Hex Chromium	Plastic	Cool to 4°C	< 0.05
Total Cyanide	Plastic	NaOH to pH >12	< 0.02
Naphthalene	Glass	Cool to 4°C	< 0.010
Phenol	Glass	H_2SO_4 to pH <2	≤ 0.012

IV. Field Analytical Data (Optional)

pH ________　Specific Conductivity ________　Temp ________

Appearance of Samples: ______________
Misc. Notes: ______________

ALLEN PARK CLAY MINE
Groundwater Monitoring Data Sheet
EPA Annual Requirements

Sampling Date: 11-24-87

Time of Sample Collection: ____________

Person(s) Collecting Sample: J. Bolin, J. Collins and B. Biesner

Laboratory Conducting Analysis: Burmah Technical Services, Inc.

WELL No. 102D QMR DESIGNATION C02U

I. Well Data USGS Coordinates
Casing Elevation 600.81'
Casing Material PVC
Casing Depth 498.30
Casing Diameter 2"
Pressure Reading in inches of H_2O + 10.77'

STATIC WATER ELEVATION(ft) 611.58' Taken on 11-23-87 Time______

II. Well Bailing Data
Device Used: Self bailing device
Material of Construction: Stainless steel with silicon stopper.
Time of Well Purging: Start/Date __________ Stop/Date __________
Flow Rate: ________mls/minute Gallons Purged: Free Flow Overnight

III. Sampling Data
Significant Weather Conditions: ____________
Sample Equipment: Direct discharge from purging device.

Annual Sample Parameters

Parameters	Container	Preservative	Analytical Results
Cadmium			< 0.01 mg/l
Lead	Plastic	HNO_3 to pH <2	< 0.05
Nickel			< 0.02
Hex Chromium	Plastic	Cool to 4°C	< 0.05
Total Cyanide	Plastic	NaOH to pH >12	< 0.02
Naphthalene	Glass	Cool to 4°C	< 0.010
Phenol	Glass	H_2SO_4 to pH <2	< 0.010

IV. Field Analytical Data (Optional)

pH ________ Specific Conductivity ________ Temp ________

Appearance of Samples: ____________
Misc. Notes: ____________

ALLEN PARK CLAY MINE
Groundwater Monitoring Data Sheet
EPA Annual Requirements

Sampling Date: 11-24-87

Time of Sample Collection: ____________

Person(s) Collecting Sample: J. Collins, J. Bolin and B. Biesner

Laboratory Conducting Analysis: Burmah Technical Services, Inc

WELL No. 103D   QMR DESIGNATION D03U

I. Well Data USGS Coordinates

Casing Elevation 605.06'
Casing Material PVC
Casing Depth 501.40

Casing Diameter 2"
Pressure Reading in inches of H_2O + 7.41'

STATIC WATER ELEVATION(ft) 612.47' Taken on 11-23-87 Time ________

II. Well Bailing Data

Device Used: Self bailing device
Material of Construction: Stainless steel with silicon stopper.
Time of Well Purging: Start/Date ____________ Stop/Date ____________
Flow Rate: ________ mls/minute   Gallons Purged: Free Flow Overnight

III. Sampling Data

Significant Weather Conditions: ____________
Sample Equipment: Direct discharge from purging device.

Annual Sample Parameters

Parameters	Container	Preservative	Analytical Results
Cadmium			< 0.01 mg/l
Lead	Plastic	HNO_3 to pH <2	< 0.05
Nickel			< 0.02
Hex Chromium	Plastic	Cool to 4°C	< 0.05
Total Cyanide	Plastic	NaOH to pH >12	< 0.02
Naphthalene	Glass	Cool to 4°C	< 0.010
Phenol	Glass	H_2SO_4 to pH <2	< 0.010

IV. Field Analytical Data (Optional)

pH ________   Specific Conductivity ________   Temp ________

Appearance of Samples: ____________
Misc. Notes: ____________

ALLEN PARK CLAY MINE
Groundwater Monitoring Data Sheet
EPA Annual Requirements

Sampling Date: 11-24-87

Time of Sample Collection: ____________

Person(s) Collecting Sample: J. Bolin, J. Collins and B. Biesner

Laboratory Conducting Analysis: Burmah Technical Services, Inc.

WELL No. 104D OMR DESIGNATION E04U

I. Well Data USGS Coordinates

Casing Elevation 603.82'
Casing Material PVC
Casing Depth 508.60

Casing Diameter 2"
Pressure Reading in inches of H_2O + 5.85'

STATIC WATER ELEVATION(ft) 609.67' Taken on 11-23-87 Time________

II. Well Bailing Data

Device Used: Self bailing device
Material of Construction: Stainless steel with silicon stopper.
Time of Well Purging: Start/Date __________ Stop/Date __________
Flow Rate: __________mls/minute Gallons Purged: Free Flow Overnight

III. Sampling Data

Significant Weather Conditions: ____________________
Sample Equipment: Direct discharge from purging device.

Annual Sample Parameters

Parameters	Container	Preservative	Analytical Results
Cadmium			< 0.01 mg/l
Lead	Plastic	HNO_3 to pH <2	< 0.05
Nickel			< 0.02
Hex Chromium	Plastic	Cool to 4°C	< 0.05
Total Cyanide	Plastic	NaOH to pH >12	< 0.02
Naphthalene	Glass	Cool to 4°C	< 0.010
Phenol	Glass	H_2SO_4 to pH <2	< 0.010

IV. Field Analytical Data (Optional)

pH __________ Specific Conductivity __________ Temp __________

Appearance of Samples: ____________________
Misc. Notes: ____________________

McNeil

RECEIVED

SEP 23 1988

Waste Management Division

V.H. SUSSMAN
S.S.

'88 MAY -4 A10:26

Ford Motor Company

3001 Miller Road
Dearborn, Michigan 48121

29 April 1988

U. S. Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, Illinois 60604

Attention: 5HE - 12

Subject: Annual Groundwater Monitoring Report
Ford Allen Park Clay Mine
EPA I.D. No. MID 980 568 711

Enclosed is the groundwater monitoring data for shallow well 5-S, as referenced in my February 29, 1988 letter. Please note that this data completes the 1987 Annual Groundwater Monitoring Report, in accordance with the reporting requirements of 40 CFR 265.94 for the subject facility.

Very truly yours,

Douglas A. Painter, Manager
Mining Department

DAP/dao

Attachment

xc: Mr. Alan J. Howard - MDNR (w/attachment)

FORD ALLEN PARK CLAY MINE
MID 980 568 711
Groundwater Monitoring Data Sheet
EPA Annual Groundwater Requirements

Well No.: Shallow Well 5-S   QMR Designation: A05U

I. Well Data USGS Coordinates

a) Casing Elevation: 598.27'
b) Casing Material: Galvanized Steel
c) Casing Depth: 580.02'
d) Casing Diameter: 2"
e) Static Water Elevation (ft): 600.07'
f) Water Level: + 1.8'
g) Date: 4-5-88
h) Time: —

II. Well Bailing Information

a) Device Employed: Teflon Bailer
b) Gallons Purged: 2 gallons
c) Date: 4-5-88
d) Time: —

III. Weather Conditions

a) Weather on Date of Bailing: Sunny, 50's
b) Weather on Date of Sampling: —

IV. Sample Collection and Laboratory Information

a) Sampling Date: 4-6-88
b) Sampling Time: —
c) Person(s) Sampling: M. Regan and B. Thomas
d) Laboratory Name: Burmah Technical Services, Inc.

V. Annual Sample Parameters

Parameter	Analytical Method	Result
Cadmium	EPA 200.7	< 0.01 mg/l
Lead	EPA 200.7	< 0.05 mg/l
Nickel	EPA 200.7	< 0.02 mg/l
Hex. Chromium	EPA 312A - Std.	< 0.05 mg/l
Total Cyanide	EPA 335.2	< 0.02 mg/l
Naphthalene	EPA 610	< 10 ug/l
Phenol	EPA 625	< 10 ug/l

VI. Comments

Sample completes 1987 requirements

Burmah

Burmah Technical Services, Inc.
Analytical Laboratories Division

408 Auburn Avenue
Pontiac, Michigan 48058

313-334-4747

Ford Motor Company
Allen Park Clay Mine
2045 Rouge Office Bldg.
3001 Miller Road
Dearborn, MI 48121-1699
Attn: Dave O'Connor

April 21, 1988

PROGRAM: SHALLOW WELL

Date Received: 4-6-88

ALD Number:	36074
Client I.D.:	5S 4-6-88
Cyanide, CN, mg/l	<0.02
Cadmium, Cd, mg/l	<0.01
Lead, Pb, mg/l	<0.05
Nickel, Ni, mg/l	<0.02
Hexavalent Chromium, Cr_{+6}, mg/l	<0.05
Naphthalene, ug/l	<10
Phenol, (by 625), ug/l	<10

Susan K. Scott
Laboratory Supervisor

SW/1L

Burmah

Ford Motor Company
Allen Park Clay Mine
Attn: Dave O'Connor

May 9, 1988

PROGRAM: EXHIBIT E - QUARTERLY

Date Received: 2-12-88

FEILD NOTES

Site I.D.	Static Water Level (ft)	Date Evacuated
A05U	2.80	2-10-88
A10D	5.50	2-10-88
A02U	Dry	

Samples were taken at two sites on 2-10-88.

All samples were preserved according to EPA guidelines and were transported to the laboratory under refrigeration.

A chain of custody record has been initiated on site and retained with out field data.

Field work was performed by Burmah Technical Services personnel B. Bieser and M. Regan.

EX/2L

Burmah

Burmah Technical Services, Inc.
Analytical Laboratories Division

408 Auburn Avenue
Pontiac, Michigan 48058

313-334-4747

Ford Motor Company
Allen Park Clay Mine
Attn: David O'Connor

December 14, 1987

PROGRAM: EXHIBIT E QUARTERLY

Sample Received: 11-5-87

FIELD NOTES

Site I.D.	Static Water Level (ft)	Date Evacuated
A05U	2.80	11-4-87
A10D	5.50	11-4-87
A02U	Dry	

Samples were taken at two sites on 11-5-87.

All samples were preserved according to EPA guidelines and were transported to the laboratory under refrigeration.

A chain of custody record has been initated on site and retained with our field data.

Field work was performed by J. Collins and B. Thomas.

Quarterly/2L

Burmah

Burmah Technical Services, Inc
Analytical Laboratories Division

408 Auburn Avenue
Pontiac, Michigan 48058

313-334-4747

Ford Motor Company
Rouge Steel Co.
Attn: David O'Connor

October 2, 1987

PROGRAM: EXHIBIT E QUARTERLY

Sample Received: 9-1-87

FIELD NOTES

Well I.D.	QMR Designation	Static Water Level (ft)	Date Evacuated
#5 Shallow	A05U	5.40	8-31-87
#10 Shallow	A10D	6.25	8-31-87
#2 Shallow	A02U	Dry	

Samples were taken at two sites on 9-1-87.

All samples were preserved according to EPA guidelines and were transported to the laboratory under refrigeration.

A chain of custody record has been initated on site and retained with our field data.

Field work was performed by J. Collins and M. Hopp.

cc: SSECO - Ed Chrasz

Quarterly/2r

FORD - ALLEN PARK L
5-18-88
Appendix D
Inspector: McNiel
MID 980568711

RCRA PART 265

SUBPART F

ERTEC INSPECTION FORMS

The facility was granted a partial groundwater monitoring waiver by U.S. EPA in 1985. It consists of:

Annual monitoring of : MW 5D, MW 5S, MW 2D, MW 2S
MW 102D, MW 103D and MW 104

Constituents to be monitored : Cadmium, Cyanide, Cr^{+6}, Lead, Napthalene, Nickel, Phenol, SWL

Evaluation: Short discussion of results.

Conditions of this partial waiver have been met

RCRA PART 265

SUBPART F

ERTEC INSPECTION FORMS

APPENDIX - A

COMPLIANCE CHECKLIST FORMS

APPENDIX A-1

FACILITY INSPECTION FORM FOR COMPLIANCE WITH INTERIM STATUS STANDARDS COVERING GROUND-WATER MONITORING

Company Name:______________________; EPA I.D. Number:____________

Company Address:____________________; Inspector's Name:____________

____

____

Company Contact/Official:____________; Branch/Organization:__________

Title:____________________________; Date of Inspection:__________

	Yes	No	Unknown	Waived
Type of facility: (check appropriately)				
a) surface impoundment	____	____		
b) landfill	____	____		
c) land treatment facility	____	____		
d) disposal waste pile*	____	____		
Ground-Water Monitoring Program				
1. Was the ground-water monitoring program reviewed prior to site visit? If "No",	____	____		
a) Was the ground-water program reviewed at the facility prior to site inspection?	____	____		
2. Has a ground-water monitoring program (capable of determining the facility's impact on the quality of groundwater in the uppermost aquifer underlying the facility) been implemented? 265.90(a)	____	____	____	____

*Listed separate from landfill for convenience of identification.

	Yes	No	Unknown	Waived
3. Has at least one monitoring well been installed in the uppermost aquifer hydraulically upgradient from the limit of the waste management area? 265.91(a)(1)	___	___		___
a) Are ground-water samples from the uppermost aquifer, representative of background ground-water quality and not affected by the facility (as ensured by proper well number, locations and depths?)	___	___		
4. Have at least three monitoring wells been installed hydraulically downgradient at the limit of the waste handling or management area? 265.91(a)(2)	___	___		
a) Do well number, locations and depths ensure prompt detection of any statistically significant amounts of HW or HW constituents that migrate from the waste management area to the uppermost aquifer?	___	___		___
5. Have the locations of the waste management areas been verified to conform with information in the ground-water program?	___	___	___	
a) If the facility contains multiple waste management components, is each component adequately monitored?	___	___		
6. Do the numbers, locations, and depths of the ground-water monitoring wells agree with the data in the ground-water monitoring system program? If "No", explain discrepancies.	___	___	___	
7. Well completion details. 265.91(c)				
a) Are wells properly cased?	___	___	___	
b) Are wells screened (perforated) and packed where necessary to enable sampling at appropriate depths?	___	___	___	
c) Are annular spaces properly sealed to prevent contamination of ground-water?	___	___	___	

	Yes	No	Unknown
8. Has a ground-water sampling and analysis plan been developed? 265.92(a)	____	____	____
a) Has it been followed?	____	____	____
b) Is the plan kept at the facility?	____	____	____
c) Does the plan include procedures and techniques for:			
1) Sample collection?	____	____	
2) Sample preservation?	____	____	
3) Sample shipment?	____	____	
4) Analytical procedures?	____	____	
5) Chain of custody control?	____	____	
9. Are the required parameters in ground-water samples being tested quarterly for the first year? 265.92(b) and 265.92 (c)(1)	____	____	
a) Are the ground-water samples analyzed for the following:			
1) Parameters characterizing the suitability of the ground-water as a drinking water supply? 265.92(b)(1)	____	____	
2) Parameters establishing ground-water quality? 265.92(b)(2)	____	____	
3) Parameters used as indicators of ground-water contamination? 265.92(b)(3)	____	____	
(i) For each indicator parameter are at least four replicate measurements obtained at each upgradient well for each sample obtained during the first year of monitoring? 265.92(c)(2)	____	____	
(ii) Are provisions made to calculate the initial background arithmetic mean and variance of the respective parameter concentrations or values obtained from the upgradient well(s) during the first year? 265.92(c)(2)	____	____	
b) For facilities which have completed first year ground-water sampling and analysis requirements:			
1) Have samples been obtained and analyzed for the ground-water quality parameters at least annually? 265.92(d)(1)	____	____	
2) Have samples been obtained and analyzed for the indicators of ground-water contamination at least semi-annually? 265.92(d)(2)	____	____	

	Yes	No	Unknown
c) Were ground-water surface elevations determined at each monitoring well each time a sample was taken? 265.92(e)	____	____	
d) Were the ground-water surface elevations evaluated annually to determine whether the monitoring wells are properly placed? 265.93(f)	____	____	
e) If it was determined that modification of the number, location or depth of monitoring wells was necessary, was the system brought into compliance with 265.91(a)? 265.93(f)	____	____	
10. Has an outline of a ground-water quality assessment program been prepared? 265.93(a)*	____	____	
a) Does it describe a program capable of determining:			
1) Whether hazardous waste or hazardous waste constituents have entered the ground water?	____	____	
2) The rate and extent of migration of hazardous waste or hazardous waste constituents in ground water?	____	____	
3) Concentrations of hazardous waste or hazardous waste constituents in ground water?	____	____	
b) After the first year of monitoring, have at least four replicate measurements of each indicator parameter been obtained for samples taken for each well? 265.93(b)	____	____	
1) Were the results compared with the initial background means from the upgradient well(s) determined during the first year?	____	____	
(i) Was each well considered individually?	____	____	
(ii) Was the Student's t-test used (at the 0.01 level of significance)?	____	____	
2) Was a significant increase (or pH decrease as well) found in the:			
(i) Upgradient wells	____	____	
(ii) Downgradient wells	____	____	
If "Yes", Compliance Checklist A-2 must also be completed.			

*See note Page 2-10

	Yes	No	Unknown
11. Have records been kept of analyses for parameters in 265.92(c) and (d)? 265.94(a)(1)	____	____	
12. Have records been kept of ground-water surface elevations taken at the time of sampling for each well? 265.94(a)(1)	____	____	
13. Have records been kept of required elevations in 265.93(b)? 265.94(a)(1)	____	____	
14. Have the following been submitted to the Regional Administrator 265.94(a)(2) :*			
a) Initial background concentrations of parameters listed in 265.92(b) within 15 days after completing each quarterly analysis required during the first year?	____	____	
b) For each well, have any parameters whose concentrations or values have exceeded the maximum contaminant levels allowed in drinking water supplies been separately identified?	____	____	
c) Annual reports including:			
1) Concentrations or values of parameters used as indicators of ground-water contamination for each well along with required evaluations under 265.93(b)?	____	____	
2) Any significant differences from initial background values in up-gradient wells separately identified?	____	____	
3) Results of the evaluation of ground-water surface elevations?	____	____	

*EPA will be proposing (Spring 1982) to replace this reporting requirement with an exception reporting system where reports will be submitted only where maximum contaminant levels or significant changes in the contamination indicators or other parameters are observed. EPA has delayed compliance stage for 14 a) above until August 1, 1982 (Federal Register, February 23, 1982, p.7841-7842) to be coupled with exception reporting in the interim.

APPENDIX A-2

INSPECTION COMPLIANCE FORM FOR A FACILITY WHICH MAY BE AFFECTING GROUND-WATER QUALITY

Company Name:______________________; EPA I.D. Number:__________

Company Address:____________________; Inspector's Name:__________

____

____

Company Contact/Official:______________; Branch/Organization:________

Title:__________________________; Date of Inspection:__________

	Yes	No	Unknown
Type of facility: (Check appropriately)			
a) surface impoundment	____	____	
b) landfill	____	____	
c) land treatment facility	____	____	
d) disposal waste pile	____	____	
1. Have comparisons of ground-water contamination indicator parameters for the upgradient well(s) 265.93(b) shown a significant increase (or pH decrease as well) over initial background?	____	____	
a) If "Yes", has this information been submitted to the Regional Administrator according to 265.94(a)(2)(ii)?	____	____	
2. Have comparisons of indicator parameters for the downgradient wells 265.93(b) shown a significant increase (or pH decrease as well) over initial background?	____	____	
a) If "Yes", were additional ground-water samples taken for those downgradient wells where the significant difference was determined? 265.93(c)(2)	____	____	
1) Were samples split in two?	____	____	
2) Was the significant difference due to human (e.g., laboratory) error? (If "Yes", do not continue.)	____	____	

	Yes	No	Unknown
3. If significant differences were not due to error, was a written notice sent to the Regional Administrator within 7 days of confirmation?	____	____	
4. Within 15 days of notification of the Regional Administrator was a certified ground-water quality assessment plan submitted? 265.93(d)(2)*	____	____	
a) Does the plan specify 265.93(d)(3) :			
1) well information (specifics)	____	____	
(a) number?	____	____	
(b) locations?	____	____	
(c) depths?	____	____	
2) sampling methods?	____	____	
3) analytical methods?	____	____	
4) evaluation methods?	____	____	
5) schedule of implementation?	____	____	
b) Does the plan allow for determination of 265.93(d)(4) :			
1) Rate and extent of migration of hazardous waste or hazardous waste constituents?	____	____	
2) Concentrations of the hazardous waste or hazardous waste constituents?	____	____	
c) Is it indicated that the first determination was made as soon as technically feasible? 265.93(d)(5)	____	____	
1) Within 15 days after the first determination was a written report containing the assessment of ground-water quality submitted to the Regional Administrator?	____	____	
d) Was it determined that hazardous waste or hazardous waste constituents from the facility have entered the ground water?	____	____	
1) If "No", was the original indicator evaluation program, required by 265.92 and 265.93(b), reinstated?	____	____	
(a) Was the Regional Administrator notified of the reinstatement of program within 15 days of the determination? 265.93(d)(6)	____	____	

*See note Page 2-10

	Yes	No	Unknown
e) If it was determined that hazardous waste or hazardous waste constituents have entered the ground water 265.93(d)(7) :			
1) For facilities where program was implemented prior to final closure, are determinations of hazardous waste or hazardous waste constituents continued on a quarterly basis? (If program was implemented during the post-closure care period, determinations made in accordance with the ground-water quality assessment plan may cease after the first determination.)	___	___	
(a) Were subsequent ground-water quality reports submitted to the Regional Administrator within 15 days of determination?	___	___	
2) Were records kept of the analyses and evaluations, specified in the ground-water quality assessment (throughout the active life of the facility)? 265.94(b)(1)	___	___	
(a) If a disposal facility, were(are) records kept throughout the post-closure period as well?	___	___	
f) Are annual reports submitted to the Regional Administrator containing the results of the ground-water quality assessment program? 265.94(b)(2)*	___	___	
1) Do the reports include the calculated or measured rate of migration of hazardous waste or hazardous waste constituents during the reporting period?	___	___	

*See note Page 4-3

	Yes	No	Unknown
3. If significant differences were not due to error, was a written notice sent to the Regional Administrator within 7 days of confirmation?			
4. Within 15 days of notification of the Regional Administrator was a certified ground-water quality assessment plan submitted? 265.93(d)(2)*			
a) Does the plan specify 265.93(d)(3) :			
1) well information (specifics)			
(a) number?			
(b) locations?			
(c) depths?			
2) sampling methods?			
3) analytical methods?			
4) evaluation methods?			
5) schedule of implementation?			
b) Does the plan allow for determination of 265.93(d)(4) :			
1) Rate and extent of migration of hazardous waste or hazardous waste constituents?			
2) Concentrations of the hazardous waste or hazardous waste constituents?			
c) Is it indicated that the first determination was made as soon as technically feasible? 265.93(d)(5)			
1) Within 15 days after the first determination was a written report containing the assessment of ground-water quality submitted to the Regional Administrator?			
d) Was it determined that hazardous waste or hazardous waste constituents from the facility have entered the ground water?			
1) If "No", was the original indicator evaluation program, required by 265.92 and 265.93(b), reinstated?			
(a) Was the Regional Administrator notified of the reinstatement of program within 15 days of the determination? 265.93(d)(6)			

*See note Page 2-10

APPENDIX A-3

INSPECTION COMPLIANCE FORM FOR DEMONSTRATING A WAIVER OF INTERIM STATUS REQUIREMENTS

Company Name:____________________; EPA I.D. Number:__________

Company Address:____________________; Inspector's Name:__________

____

____

Company Contact:____________________; Branch/Organization:__________

Title:____________________; Date of Inspection:__________

	Yes	No	Unknown
1. Is a written waiver demonstration kept at the site?	____	____	
2. Is the demonstration certified by a qualified geologist or geotechnical engineer? 265.90(c)	____	____	
3. Does the waiver demonstration establish:			
a) The potential for migration of hazardous waste or hazardous waste constituents from the facility to the uppermost aquifer? 265.90(c)(1)	____	____	
b) An evaluation of a water balance including:			
1) Precipitation?	____	____	
2) Evapotranspiration?	____	____	
3) Runoff?	____	____	
4) Infiltration? (including any liquid in surface impoundments)	____	____	
c) Unsaturated zone characteristics?	____	____	
1) Geologic materials?	____	____	
2) Physical properties?	____	____	
3) Depth to ground water?	____	____	

	Yes	No	Unknown
d) The potential for hazardous waste or hazardous waste constituents which may enter the uppermost aquifer to migrate to a water supply well or surface water, by evaluation of: 265.90(c)(2)			
1) Saturated zone characteristics, including:			
(a) Geologic materials?	____	____	
(b) Physical properties?	____	____	
(c) Rate of ground-water flow?	____	____	
2) Proximity of the facility to water supply wells or surface water?	____	____	

APPENDIX -B

GROUND-WATER MONITORING AND ALTERNATE SYSTEM TECHNICAL INFORMATION FORM

APPENDIX B

GROUND-WATER MONITORING AND ALTERNATE SYSTEM TECHNICAL INFORMATION FORM

1.0 Background Data:

Company Name:______________________; EPA I.D.#:______________

Company Address:______________________

____

____

Inspector's Name:______________________; Date:______________

1.1 Type of facility (check appropriately):

1.1.1 surface impoundment ____
1.1.2 landfill ____
1.1.3 land treatment facility ____
1.1.4 disposal waste pile ____

1.2 Has a ground-water monitoring system been established? (Y/N) ____

1.2.1 Is a ground-water quality assessment program outlined or proposed? (Y/N) ____

If Yes,

1.2.2 Was it reviewed prior to the site visit? (Y/N) ____

1.3 Has a ground-water quality assessment program been implemented or proposed at the site? (Y/N) ____

If yes, Appendix C, Ground-Water Quality Assessment Program Technical Information Form must be utilized also.

2.0 Regional/Facility Map(s)

2.1 Is a regional map of the area, with the facility delineated, included? (Y/N) ____

If yes,

2.1.1 What is the origin and scale of the map?______________________

____

2.1.2 Is the surficial geology adequately illustrated? (Y/N) ____

2.1.3 Are there any <u>significant</u> topographic or surficial features evident? (Y/N) _____

If yes, describe ____________________

____

2.1.4 Are there any streams, rivers, lakes, or wet lands near the facility? (Y/N) _____

If yes, indicate approximate distances from the facility ____________________

____

____

2.1.5 Are there any discharging or recharging wells near the facility? (Y/N) _____

If yes, indicate approximate distances from the facility. ____________________

____

____

2.2 Is a regional hydrogeologic map of the area included? (This information may be shown on 2.1) (Y/N) _____

If yes:

2.2.1 Are major areas of recharge/dishcarge shown? (Y/N) _____

If yes, describe. ____________________

____

____

2.2.2 Is the regional ground-water flow direction indicated? (Y/N) _____

2.2.3 Are the potentiometric contours logical? (Y/N) _____
If not, explain. ____________________

____

____

2.3 Is a facility plot plan included? (Y/N) _____

2.3.1 Are facility components (landfill areas, impoundments, etc.) shown? (Y/N) _____

2.3.2 Are any seeps, springs, streams, ponds, or wetlands indicated? (Y/N) _____

2.1.3 Are there any <u>significant</u> topographic or surficial features evident? (Y/N) _____

If yes, describe ____

____

2.1.4 Are there any streams, rivers, lakes, or wet lands near the facility? (Y/N) _____

If yes, indicate approximate distances from the facility ____

____

____

2.1.5 Are there any discharging or recharging wells near the facility? (Y/N) _____

If yes, indicate approximate distances from the facility. ____

____

____

2.2 Is a regional hydrogeologic map of the area included? (This information may be shown on 2.1) (Y/N) _____

If yes:

2.2.1 Are major areas of recharge/dishcarge shown? (Y/N) _____

If yes, describe. ____

____

____

2.2.2 Is the regional ground-water flow direction indicated? (Y/N) _____

2.2.3 Are the potentiometric contours logical? (Y/N) _____
If not, explain. ____

____

____

2.3 Is a facility plot plan included? (Y/N) _____

2.3.1 Are facility components (landfill areas, impoundments, etc.) shown? (Y/N) _____

2.3.2 Are any seeps, springs, streams, ponds, or wetlands indicated? (Y/N) _____

2.3.3 Are the locations of any monitoring wells, soil borings, or test pits shown? (Y/N) _____

2.3.4 Is the facility a multi-component facility? (Y/N) _____

If yes:

2.3.4.1 Are individual components adequately monitored? (Y/N) _____

2.3.4.2 Is a Waste Management Area delineated? (Y/N) _____

2.4 Is a site water table (potentiometric) contour map included? (Y/N) _____

If yes,

2.4.1 Do the potentiometric contours appear logical based on topography and presented data? (Consult water level data) (Y/N) _____

2.4.2 Are groundwater flowlines indicated? (Y/N) _____

2.4.3 Are static water levels shown? (Y/N) _____

2.2.4 May hydraulic gradients be estimated? (Y/N) _____

2.4.5 Is at least one monitoring well located hydraulically upgradient of the waste management area(s)? (Y/N) _____

2.4.6 Are at least three monitoring wells located hydraulically downgradient of the waste management area(s)? (Y/N) _____

2.4.7 By their location, do the upgradient wells appear capable of providing representative ambient groundwater quality data? (Y/N) _____

If no, explain.______________________________

____

____

3.0 Soil Boring/Test Pit Details

3.1 Were soil borings/test pits made under the supervision of a qualified professional? (Y/N) _____

If yes,

3.1.1 Indicate the individual(s) and affiliation(s): ____________________

____

____

3.1.2 Indicate the drilling/excavating contractor, if known ____________

____

3.2 If soil borings/test pits were made, indicate the method(s) of drilling/excavating:

- Auger (hollow or solid stem) _____
- Mud rotary _____
- Air rotary _____
- Reverse rotary _____
- Cable tool _____
- Jetting _____
- Other, including excavation (explain) ____________________

____

3.3 List the number of soil borings/test pits made at the site

3.3.1 Pre-existing _____

3.3.2 For RCRA compliance _____

3.4 Indicate borehole diameters and depths (if different diameters and depths use TABLE B-1).

3.4.1 Diameter: ____________________________________

3.4.2 Depth: ____________________________________

3.5 Were lithologic samples collected during drilling? (Y/N) _____

If yes,

3.5.1 How were samples obtained? (Check method(s))

- Split spoon _____
- Shelby tube, or similar _____
- Rock coring _____
- Ditch sampling _____
- Other (explain) ____________________

____

INFORMATION TABLE B-1

BORING NO.	DEPTH	DIAMETER

3.5.2 At what interval were samples collected? ______________________________

____

3.5.3 Were the deposits or rock units penetrated described? (boring logs, etc.) (Y/N) _____

3.6 If test pits were excavated at the site, describe procedures. ______________________________

____

____

4.0 Well Completion Detail

4.1 Were the wells installed under the supervision of a qualified professional? (Y/N) _____

If yes:

4.1.1 Indicate the individual and affiliation, if known ______________________________

____

____

4.1.2 Indicate the well construction contractor, if known ______________________________

____

____

4.2 List the number of wells at the site

4.2.1 Pre-existing _____

4.2.2 For RCRA Compliance _____

4.3 Well construction information (fill out INFORMATION TABLE B-2)

4.3.1 If PVC well screen or casing is used, are joints (couplings):

- Glued on _____
- Screwed on _____

4.3.2 Are well screens sand/gravel packed? (Y/N) _____

INFORMATION TABLE B-2

	WELL NO.						
	GROUND ELEVATION						
	TOTAL DEPTH						
WELL CASING	TYPE MATERIAL						
	DIAMETER						
	LENGTH						
	STICK-UP						
	TOP ELEVATION						
	BOTTOM ELEVATION						
WELL SCREEN	DEPTH TOP/BOTTOM						
	TYPE MATERIAL						
	DIAMETER						
	LENGTH						
	SLOT SIZE						
	TOP ELEVATION						
	BOTTOM ELEVATION						
OPEN HOLE OR SAND/GRAVEL PACK	DEPTH TOP/BOTTOM						
	DIAMETER						
	LENGTH						
	TOP ELEVATION						
	BOTTOM ELEVATION						

4.3.3 Are annular spaces sealed? (Y/N) _____

If yes, describe:

- bentonite slurry _____
- Cement grout _____
- Other (explain) ____________________

____

- Thicknesses of seals ____________________

4.3.4 If "open hole" wells, are the cased portions sealed in place? (Y/N) _____

If yes, describe how: ____________________

____

____

4.3.5 Are there cement surface seals? (Y/N) _____

If yes,

- How thick? ____________________

4.3.6 Are the wells capped? (Y/N) _____

If yes,

- Do they lock? (Y/N) _____

4.3.7 Are protective standpipes cemented in place? (Y/N) _____

4.3.8 Were wells developed? (Y/N) _____

If yes, check appropriate method(s):

- Air lift pumping _____
- Pumping and surging _____
- Jetting _____
- Bailing _____
- Other (explain) ____________________

____

5.0 <u>Aquifer Characterization</u>

5.1 Has the extent of the uppermost saturated zone (aquifer) in the facility area been defined? (Y/N) _____

If yes,

5.1.1 Are soil boring/test pit logs included? (Y/N) _____

5.1.2 Are geologic cross-sections included? (Y/N) _____

5.2 Is there evidence of confining (low permeability) layers beneath the site? (Y/N) _____

If yes,

5.2.1 Is the areal extent and continuity indicated? (Y/N) _____

5.2.2 Is there any potential for saturated conditions (perched water) to occur above the uppermost aquifer? (Y/N) _____

If yes, give details: ____

____

____

a) Should or is this perched zone being monitored? (Y/N) _____

Explain ____

____

5.2.3 What is the lithology and texture of the uppermost saturated zone (aquifer)? ____

____

____

5.2.4 What is the saturated thickness, if indicated? ____

____

5.3 Were static water levels measured? (Y/N) _____

If yes,

5.3.1 How were the water levels measured (check method(s)).

- Electric water sounder _____
- Wetted tape _____
- Air line _____
- Other (explain) ____

____

5.3.2 Do fluctuations in static water levels occur? (Y/N) _____

If yes,

5.3.2.1 Are they accounted for (e.g. seasonal, tidal, etc.)? (Y/N) _____

If yes, describe: ____

____

____

5.3.2.2 Do the water level fluctuations alter the general ground-water gradients and flow directions? (Y/N) _____

If yes,

5.3.2.3 Will the effectiveness of the wells to detect contaminants be reduced? (Y/N) _____

Explain ____

____

____

5.3.2.4 Based on water level data, do any head differentials occur that may indicate a vertical flow component in the saturated zone? (Y/N) _____

If yes, explain ____

____

____

5.4 Have aquifer hydraulic properties been determined? (Y/N) _____

If yes,

5.4.1 Indicate method(s):

- Pumping tests _____
- Falling/constant head tests _____
- Laboratory tests (explain) ____________________

____

____

5.4.2 If determined, what are the values for:

- Transmissivity _____
- Storage coefficient _____
- Leakage _____
- Permeability _____
- Porosity _____
- Specific capacity _____

5.4.3 In cases where several tests were undertaken, were discrepancies in the results evident? (Y/N) _____

If yes, explain ____

____

5.4.4 Were horizontal ground-water flow velocities determined? (Y/N) _____

If yes, indicate rate of movement ____________________

____

6.0 Well Performance

6.1 Are the monitoring wells screened in the uppermost aquifer? (Y/N) _____

6.1.1 Is the full saturated thickness screened? (Y/N) _____

6.1.2 For single completions, are the intake areas in the: (check appropriate levels)

- Upper portion of the aquifer _____
- Middle of the aquifer _____
- Lower portion of the aquifer _____

6.1.3 For well clusters, are the intake areas open to different portions of the aquifer? (Y/N) _____

6.1.4 Do the intake levels of the monitoring wells appear to be justified due to possible contaminant density and groundwater flow velocity? (Y/N) _____

7.0 Ground-Water Quality Sampling

7.1 Is a sampling (groundwater quality) program and schedule included? (Y/N) _____

7.2 Are sample collection field procedures clearly outlined? (Y/N) _____

7.2.1 How are samples obtained: (check method(s))

- Air lift pump _____
- Submersible pump _____
- Positive displacement pump _____
- Centrifugal pump _____
- Peristaltic or other suction-lift pump _____
- Bailer _____
- Other (describe) _____________________

____

7.2.2 Are all wells sampled with the same equipment and procedures? (Y/N) _____

If no, explain ____

____

____

7.2.3 Are adequate provisions included to clean equipment after sampling to prevent cross-contamination between wells? (Y/N) _____

7.2.4 Are organic constituents to be sampled? (Y/N) _____

If yes,

7.2.4.1 Are samples collected with equipment to minimize absorption and volatilization? (Y/N) _____

If yes,

Describe equipment ____

____

____

8.0 <u>Sample Preservation and Handling</u>

8.1 Have appropriate sample preservation and preparation procedures been followed (filtration and preservation where appropriate)? (Y/N) _____

8.2 Are samples refrigerated? (Y/N) _____

8.3 Are EPA recommended sample holding period requirements adhered to? (Y/N) _____

8.4 Are suitable container types used? (Y/N) _____

8.5 Are provisions made to store and ship samples under cold conditions (ice packs, etc.)? (Y/N) _____

8.6 Is a chain of custody control procedure clearly defined? (Y/N) _____

8.7 Is a specific chain of custody form illustrated? (Y/N) _____

If yes,

8.7.1 Will this form provide an accurate record of sample possession from the moment the sample is taken until the time it is analyzed? (Y/N) _____

9.0 <u>Sample Analysis and Record Keeping</u>

9.1 Is sample analysis performed by a qualified laboratory? (Y/N) _____

Indicate lab ____

9.2 Are analytical methods described in the records? (Y/N) _____

9.2.1 Are analytical methods acceptable to EPA? (Y/N) _____

9.3 Are the required drinking water suitability parametters tested for? (Y/N) _____

9.4 Are the required groundwater quality parameters tested for? (Y/N) _____

9.5 Are the required groundwater contamination indicator parameters tested for? (Y/N) _____

9.6 Are any analytical parameters determined in the field? (Y/N) _____

Identify:

- pH _____
- Temperature _____
- Specific conductance _____
- Other (describe) _____________________

____

9.7 Is a plan included to record information about each sample collected during the groundwater monitoring program? (Y/N) _____

9.7.1 Are field activity logs included? (Y/N) _____

9.7.2 Are laboratory results included? (Y/N) _____

9.7.3 Are field procedures recorded? (Y/N) _____

9.7.4 Are field parameter determinations included? (Y/N) _____

9.7.5 Are the names and affiliation of the field personnel included? (Y/N) _____

9.8 Are statistical analyses planned or shown for all water quality results where necessary? (Y/N) _____

9.8.1 Is an analysis program set-up which adheres to EPA guidelines? (Y/N) _____

9.8.2 Is Student's t-test utilized? (Y/N) _____
If other evaluation procedure used, identify _____________________

____

9.8.3 Are provisions made for submitting analysis reports to the Regional Administrator? (Y/N) _____

10.0 <u>Site Verification</u>

10.1 Plot Plan indicating the locations of various facility components, ground-water monitoring wells, and surface waters? (Y/N) _____

10.1.1 Is the plot plan used for the inspection the same as in the monitoring program plan documentation? (Y/N) _____

If not, explain _____________________________________

____

10.1.2 Are all of the components of the facility identified during the inspection addressed in the monitoring program documentation? (Y/N) _____

If not, explain ____________________

____

10.1.3 Are there any streams, lakes or wetlands on or adjacent to the site? (Y/N) _____

- If yes, indicate distances from waste management areas __________

____

____

10.1.4 Are there any signs of water quality degradation evident in the surface water bodies? (Y/N) _____

If yes, explain ____________________

____

____

10.1.5 Is there any indication of distressed or dead vegetation on or adjacent to the site? (Y/N) _____

If yes, explain ____________________

____

____

10.1.6 Are there any significant topographic or surficial features on or near the site (e.g., recharge or discharge areas)? (Y/N) _____

If yes, explain ____________________

____

10.1.7 Are the monitor well locations and numbers in agreement with the monitoring program documentation? (Y/N) _____

If no, explain ____________________

____

10.1.7.1 Were locations and elevations of the monitor wells surveyed into some known datum? (Y/N) _____

If not, explain ____________________

____

10.1.7.2 Were the wells sounded to determine total depth below the surface? (Y/N) _____

If not, explain ____

____

10.1.7.3 Were discrepancies in total depth greater than two feet apparent in any well? (Y/N) _____

If yes, explain ____

____

10.1.8 Was ground water encountered in all monitoring wells? (Y/N) _____

If not, indicate which well(s) were dry ______________________

____

10.1.9 Were water level elevations measured during the site visit? (Y/N) _____

If yes, indicate well number and water level elevation ____________

____

If not, explain ____

____

APPENDIX - C

GROUND-WATER QUALITY ASSESSMENT PROGRAM INFORMATION FORM

APPENDIX C

GROUND-WATER QUALITY ASSESSMENT PROGRAM INFORMATION FORM

Company Name:______________________; EPA I.D.#:______________

Company Address:______________________

____

____

Inspector's Name:______________________; Date:______________

1.0 Background

1.1 List the constituents (contaminants) originating from the waste management area: (use separate sheet if necessary______________________

____

____

1.2 Have the concentrations of the hazardous waste or hazardous waste constituents shown significant increases in:

- upgradient monitoring wells (Y/N) ____
- downgradient monitoring wells (Y/N) ____

1.2.1 List or indicate on a map, the wells which have shown significant increases: (use separate sheet if necessary)______________________

____

____

1.3 Were the significant increases in contaminant concentration determined through the use of the student's t-Test?

If no, (Y/N) ____

1.3.1 Explain procedure used______________________

____

____

1.4 Has the possibility of error (e.g., laboratory) been eliminated? (Y/N) ____

1.4.1 Explain______________________

____

____

Contaminant Characteristics

2.1 If available, list the chemical and physical properties of the contaminants which have been detected in the ground water: (density, solubility, etc.). Include on a separate sheet if list is extensive ______________________

____

____

3.0 Implementation of the Assessment Program

3.1 Has the extent of the migration of hazardous waste or hazardous waste constituents been determined? (Y/N) ____

If yes,

3.1.1 Indicate how: (check appropriate method(s))

- additional ground-water monitoring wells ____________
- geophysical methods ____________
- computer simulation ____________
- other, explain ____________

____

3.2 Were monitoring wells installed? (Y/N) ____

If yes,

3.2.1 Record monitoring well/peizometer completion data on INFORMATION TABLE C-1.

3.2.2 Were well clusters (nests) used or were wells with multiple intake areas constructed? Give details ______________________

____

____

3.2.3 Show the numbers and locations of the additional wells/peizometers on a site map.

3.2.4 Are the locations of the wells/piezometers justified in view of the water table or potentiometric surface map? (Y/N) ____
Give details ______________________

____

____

INFORMATION TABLE C-1

	WELL NO.						
	GROUND ELEVATION						
	TOTAL DEPTH						
WELL CASING	TYPE MATERIAL						
	DIAMETER						
	LENGTH						
	STICK-UP						
	TOP ELEVATION						
	BOTTOM ELEVATION						
WELL SCREEN	DEPTH TOP/BOTTOM	/	/	/	/	/	/
	TYPE MATERIAL						
	DIAMETER						
	LENGTH						
	SLOT SIZE						
	TOP ELEVATION						
	BOTTOM ELEVATION						
OPEN HOLE OR SAND/GRAVEL PACK	DEPTH TOP/BOTTOM	/	/	/	/	/	/
	DIAMETER						
	LENGTH						
	TOP ELEVATION						
	BOTTOM ELEVATION						

3.2.5 Are the depths of the monitoring wells/ piezometers justified due to the relative characteristics (e.g., densities) of the contaminants? (Y/N) _____
Give details ______________________________

____

____

3.2.6 List any other methods (e.g., soil sample analysis) used to document the extent of the contamination. (use separate sheet if necessary) ______________________________

____

____

3.3 Has the rate of contaminant migration been determined? (Y/N) _____

If yes, what is it and how was it determined? ______________________________

____

____

3.3.1 Does the rate of migration differ for various contaminants? (Y/N) _____
Give details ______________________________

____

____

3.3.2 If known, what is the cause (reason) of (for) this differential in migration rates? ______________________________

____

____

APPENDIX - D

WAIVER DEMONSTRATION TECHNICAL INFORMATION FORM

APPENDIX D

WAIVER DEMONSTRATION TECHNICAL INFORMATION FORM

Company Name: Ford-Allen Park L.F.; EPA ID.#: MID 980568711
Company Address: 17250 Oakwood Blvd.
Allen Park, MI 48121

Inspector's Name: McNiel; Date: 5-18-88

1.0 Site Characterization

Regional Map (U.S.G.S., 7.5 min. Topographic Quadrangle Map, or similar) showing facility location with water supply wells near the facility indicated.

1.0.1 Are there discharging wells near the facility? (Y/N) N

If yes, give distances to wells ______

1.0.1.1 Which aquifers in the vicintiy provide water supplies? N/A

1.0.1.2 What is the estimated withdrawal (diversion) rate from these aquifers? N/A

1.0.2 Are there any streams, rivers, or lakes near the facility? (Y/N) Y

1.0.2.1 If so, indicate approximate distances from the facility. Rouge River ≈ ½ mile
Tyre & Allen Drain - 500'

1.1 Regional Hydrogeologic/Surficial Geologic Map

1.1.1 Is the surficial geology adequately illustrated? (Y/N) Yes

1.1.2 Are areas of recharge/discharge shown? (Y/N) Yes

1.1.3 Is regional groundwater flow direction indicated? (Y/N) Yes

1.1.4 Are the water table or potentiometric contours logical? (Y/N) Yes

1.2 Map of Facility (scale at least 1" = 200'), showing the locations of facility components (e.g., surface impoundments, and disposal areas), and groundwater monitoring wells, springs, seeps, streams, etc.

1.2.1 Is the facility a multi-component facility? (Y/N) N

1.2.2 Are locations of test borings (or pits) and observation wells shown? (Y/N) Y

1.2.2.1 Are borings, pits, or wells located in or near the waste management area? (Y/N) Y

If yes,

1.2.2.2 Do the borings, pits, or wells appear to be of such number, and depth to adequately characterize the substrate? (Y/N) Y

Give brief detail ______

1.3 Boring Logs and Geologic Cross Sections

1.3.1 Are there logs of the borings or test pits? (Y/N) Y

1.3.2 How are the sub-surface materials described: (check as appropriate)

1.3.2.1 Unified Soil Classification System ✓

1.3.2.2 U.S.D.A. Soil Classification System ______

1.3.2.3 Burmeister Classification System ______

1.3.2.4 Other (explain) ______

1.3.3 Are geologic cross-sections included? (Y/N) Y

1.3.4 Is there evidence of confining (low permeability) layers beneath the facility? (Y/N) Y

2.0 <u>Waste Characterization</u>

2.1 Has the waste material been stabilized in any way to preclude the potential of leachate being generated? (Y/N) N

If yes, briefly explain methods ______

2.2 Have specially engineered features been incorporated into the facility design to minimize the migration of leachate? (Y/N) N

If yes, briefly explain ______

______

3.0 Water Balance

3.1 Is precipitation data included? (Y/N) ~~N~~ Y

3.1.1 How is it tabulated? (check one)

- Daily ______
- Weekly ______
- Monthly ✓
- Annually ______

3.1.2 Source of data (check one)

- U.S. Weather Service ______
- State Agency ______
- Other Source ______

Identify ______

______

3.1.3 Length of record, in years ______

3.1.4 Distance of measuring point from the facility ______

3.2 Is actual evapotranspiration (AET) data included? (Y/N) N

3.2.1 Is the source of AET data indicated? (Y/N) ______

If yes, give reference ______

______

3.3 Is run-off calculated? (Y/N) N

3.3.1 Is the technique referenced? (Y/N) ______

If yes, give reference ______

______

3.4 Is infiltration data included? (Y/N) N

3.4.1 Is source of data referenced? (Y/N) ______

If yes, give reference ______

______

3.5 Is there a positive net infiltration recorded? (Y/N) ?

If yes, how much? ______

4.0 Unsaturated Zone Characteristics

4.1 Has the applicant demonstrated that the unsaturated zone will isolate any waste derived leachate from the ~~water table~~ uppermost aquifer, chemically or physically? (Y/N) Y

Briefly describe mechanism(s) 40' 10^{-8} clay - demonstrated upward gradient through clay & modelling

4.2 Physical Properties

4.2.1 Has the applicant defined the unsaturated thickness and areal variability? (Y/N) Y

Briefly describe ______

4.2.2 Has the primary and secondary porosity (if any) of the unsaturated zone been determined? (Y/N) N

Briefly describe ______

4.2.3 Have hydraulic conductivity curves for each sediment type comprising the unsaturated zone been established? (Y/N) Y

4.2.4 Have textural analyses been performed? (Y/N) Y

4.2.5 Have bulk densities been estimated? (Y/N) Y

4.3 Chemical Properties

4.3.1 Has cation exchange been cited as an attenuation means? (Y/N) N

If yes,

4.3.1.1 Type of clay ______

4.3.1.2 Percent of clay ______

4.3.1.3 Percent of organics ______

4.3.1.4 pH of materials ______

4.3.2 Have other attenuation mechanisms, if any, been adequately explained? (Y/N) N

If yes, cite mechanism:

4.3.2.1 Biodegradation ____

4.3.2.2 Complexation ____

4.3.2.3 Precipitation ____

4.3.2.4 Chelation ____

4.3.2.5 Other ____

5.0 Saturated Zone Physical Characteristics

5.1 Have the saturated zone hydrologic properties been determined? (Y/N) Y

If yes, were pumping tests performed to determine (check appropriate determinations and give results)

5.1.1 Transmissivity —

5.1.2 Hydraulic Conductivity —

5.1.3 Storage Coefficient —

5.1.4 Leakage —

5.2 How many tests were performed? N/A

5.2.1 The duration(s) of test(s) ____

5.2.2 The length(s) of the recovery test(s) ____

5.3 Were other insitu tests performed? (Y/N) N

(check appropriate tests)

5.3.1 Falling head tests ____

5.3.2 Constant head tests ____

5.3.3 Packer tests ____

5.3.4 Other ____

Explain ____

5.4 Was the saturated thickness determined? (Y/N) Y

5.5 Are static water level measurements included? (Y/N) Y

5.6 Is a site water table (equipotential) contour map included? (Y/N) Y

5.6.1 Does the contour map appear logical based on the presented data and topography? (Y/N) Y

5.6.2 Are groundwater flowlines indicated? (Y/N) Y

5.6.3 Are hydraulic gradients included? (Y/N) N

5.6.4 Are flow velocities included? (Y/N) N

5.7 Is there any indication of vertical flow in the saturated zone? (Y/N) Y

5.8 Saturated Zone Chemical Properties of Ground Water

5.8.1 Have water quality analyses been performed to establish background data? (Y/N) Y

5.8.2 Does background information indicate that the aquifer may be degraded in any way? (Y/N) N

6.0 Computer Modeling

6.1 Was a computer simulation utilized in the demonstration? (Y/N) Y

Check appropriate model:

6.1.1 Mass transport ____

6.1.2 Flow model ____

6.2 Type of model? (check appropriate type)

6.2.1 Numerical ____

6.2.2 Analytic ____

6.2.3 Reference for model? Diffusion analysis - Dr. Donald Gray - Professor U of M - Dept of Civil Engineering

6.2.4 Does the data appear to warrant the use of modeling techniques? (Y/N) Y

If not, explain ____________________

Wells

Date: 5-18-88

TOC	Well	TIME	Water Level Above TOC	SWL
605.06	103D	1100	67.8" + 23.75"	612.69
600.81	102D	1113	NR	
603.82	104D	1117	NR	
596.14	5D	1132	NR 67.2 + 23 $\frac{5}{8}$	603.71
600.76	2D	1141	H_2O below casing (did not read)	

HYDROGEOLOGICAL EVALUATION

The facility was issued a partial waiver to the groundwater monitoring requirements of 40 CFR 265 Subpart F by U.S. EPA in 1985. This partial waiver consists of the following: Annual monitoring of wells 5-D, 5-S, 2-D, 2-S, 102-D, 103-D, amd 104-D for cadmium, cyanide (complexed), hexavalent chromium, lead, napthalene, nickel, phenol and static water level.

The facility was issued an operating license under Michigan Act 64 in 1982 which required a full groundwater monitoring program. This requirement, as well as many others, was contested by Ford. As such, they were not required to comply with that program until such time as a contested case hearing was held to resolve the matter. To date, no such hearing has been held and Ford has not monitored the site groundwater as required by their operating license. The requirements of the U.S. EPA partial waiver have been met.

Ford submitted a reapplication for a new operating license in 1986. As part of this application, they requested a waiver of the groundwater monitoring requirements under R299.9611(3)(b) and 40 CFR 264.90(b)(4).

Both Act 64 and RCRA contain provisions for waiving the requirements of a groundwater monitoring system for land disposal facilities which are located in areas with favorable geological conditions. A waiver is to be granted when the Director finds that there is no potential for migration of liquid from the regulated unit to the uppermost aquifer during the active life of the regulated unit (including the closure period) and the post-closure care period. [R299.9611(3)(b) and 40 CFR 264.90(b)(4)]

MDNR intends to grant the waiver request. The remainder of this report will discuss the site conditions and investigations performed which are the basis for the granting of the waiver.

Discussions have been ongoing for the last five years between the company and MDNR in order to develop a sufficient data base for a determination to be made regarding the usefulness of monitoring the "uppermost" aquifer. Site conditions have been shown to include a minimum of thirty feet of natural clay beneath the lowermost portion of the landfill. This clay possesses a hydraulic conductivity of 6.0×10^{-8} cm/sec or less at all points. The "uppermost" aquifer is located approximately 70-85 feet below ground surface and is composed of one to six feet of medium sand. It is highly confined with a potentiometric surface at or above ground level. There are no known domestic wells completed within this aquifer due to

poor water quality and yield. The company was asked to demonstrate the existence of the upward gradient throughout the confining clay unit. The installation and monitoring of three piezometer nests has demonstrated the existence of an **upward** gradient of 0.1 to 0.2 ft/ft through the clay unit from the uppermost aquifer. Modelling has also been performed by Dr. Donald Gray (University of Michigan) to evaluate the significance of chemical diffusion. This modelling has shown that it will take approximately 1000 years for leachate constituents to reach the uppermost aquifer at 1/100th their original concentration. These numbers are based on worst case scenarios of a failed leachate collection system and no adsorption of chemicals on the soil matrix.

It should be noted that other early detection monitoring systems will be in-place to assure no leakage from the regulated units. They include:

- Surface Water monitoring

- Soil monitoring

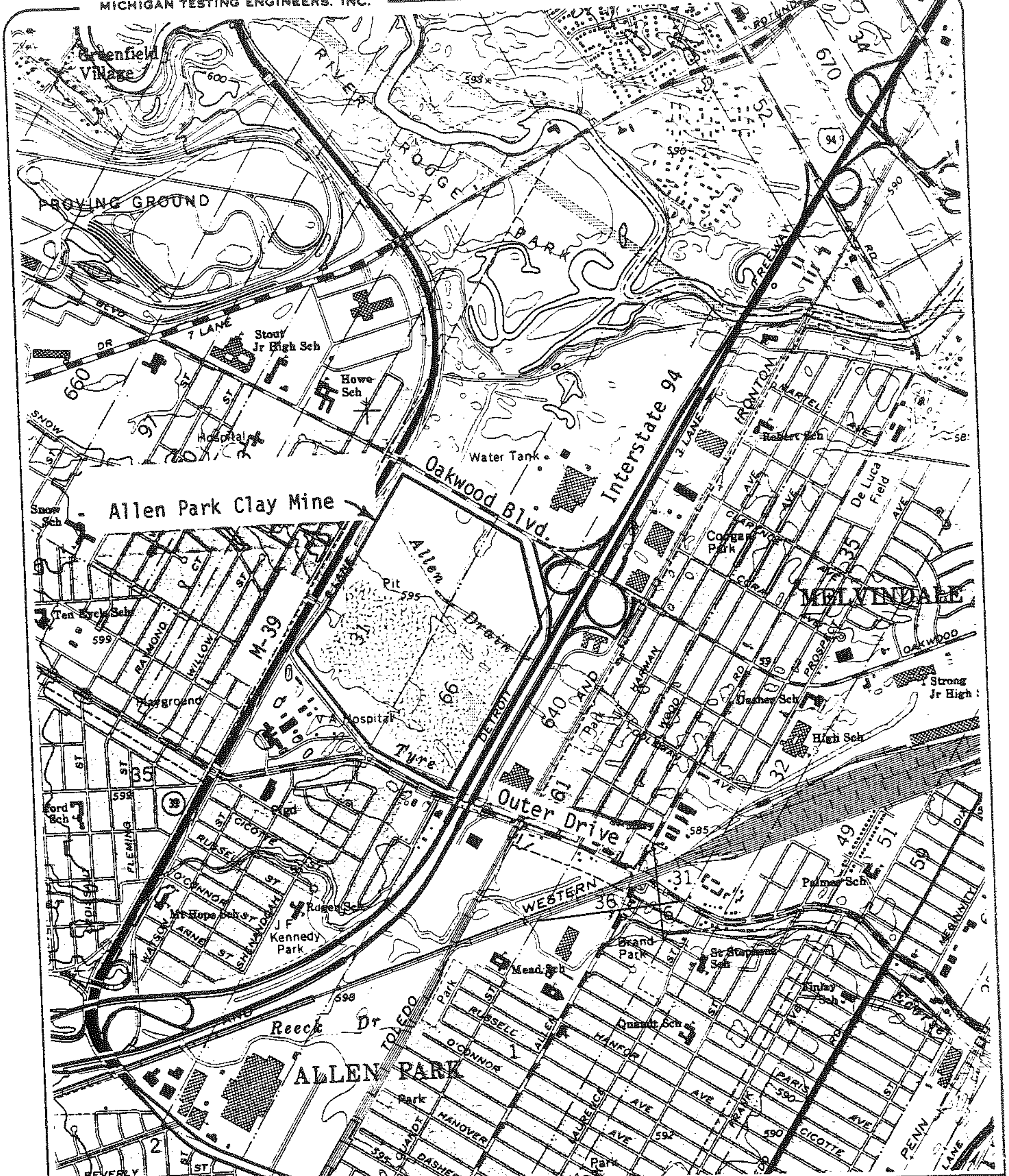
- Air monitoring

- Lysimeter monitoring (Cell I)

- Leak Detection monitoring (Cell II)

- Potentiometric monitoring of the uppermost aquifer will be required on a regular basis to verify that the conditions on which the waiver is granted do not change.

MICHIGAN TESTING ENGINEERS, INC.

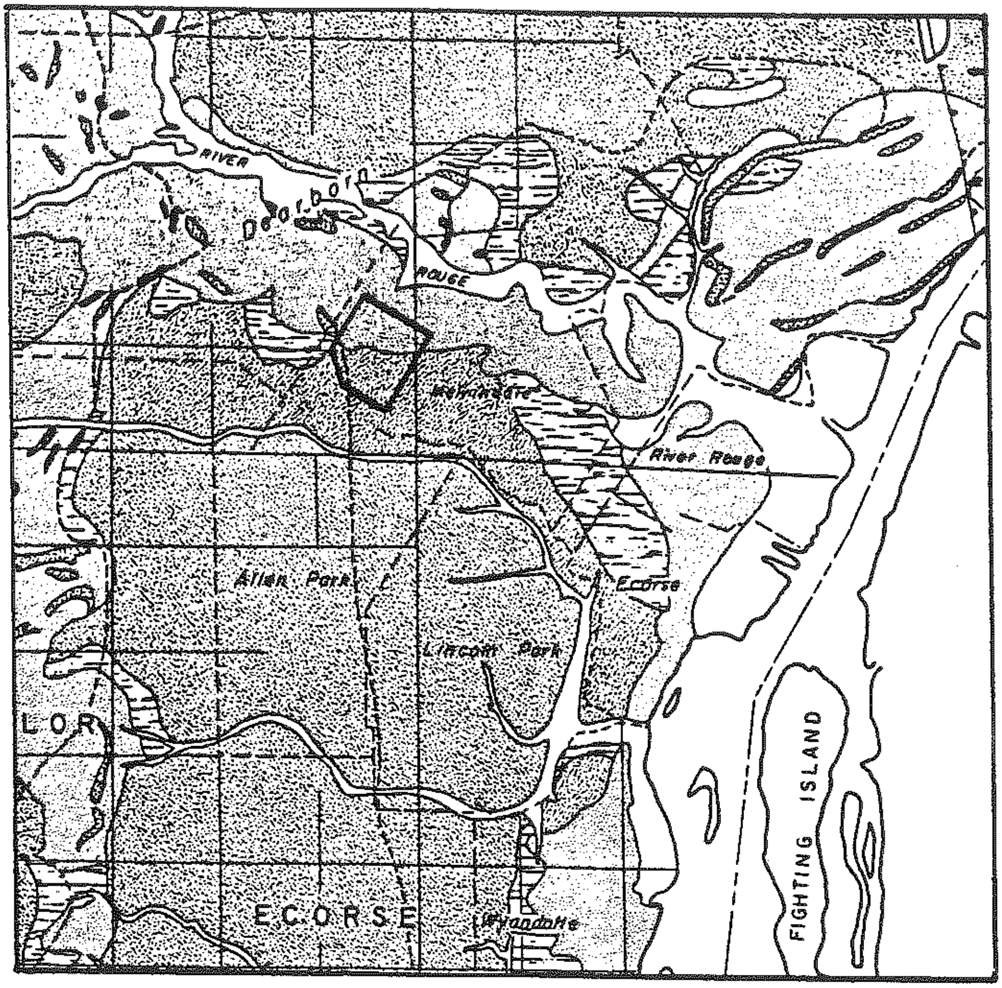


0 1000 2000 3000 4000 5000

Scale - Feet
Contour Interval 5 Feet
Datum is Mean Sea Level

Allen Park Clay Mine
Disposal Landfill
Allen Park, Michigan
Wayne County

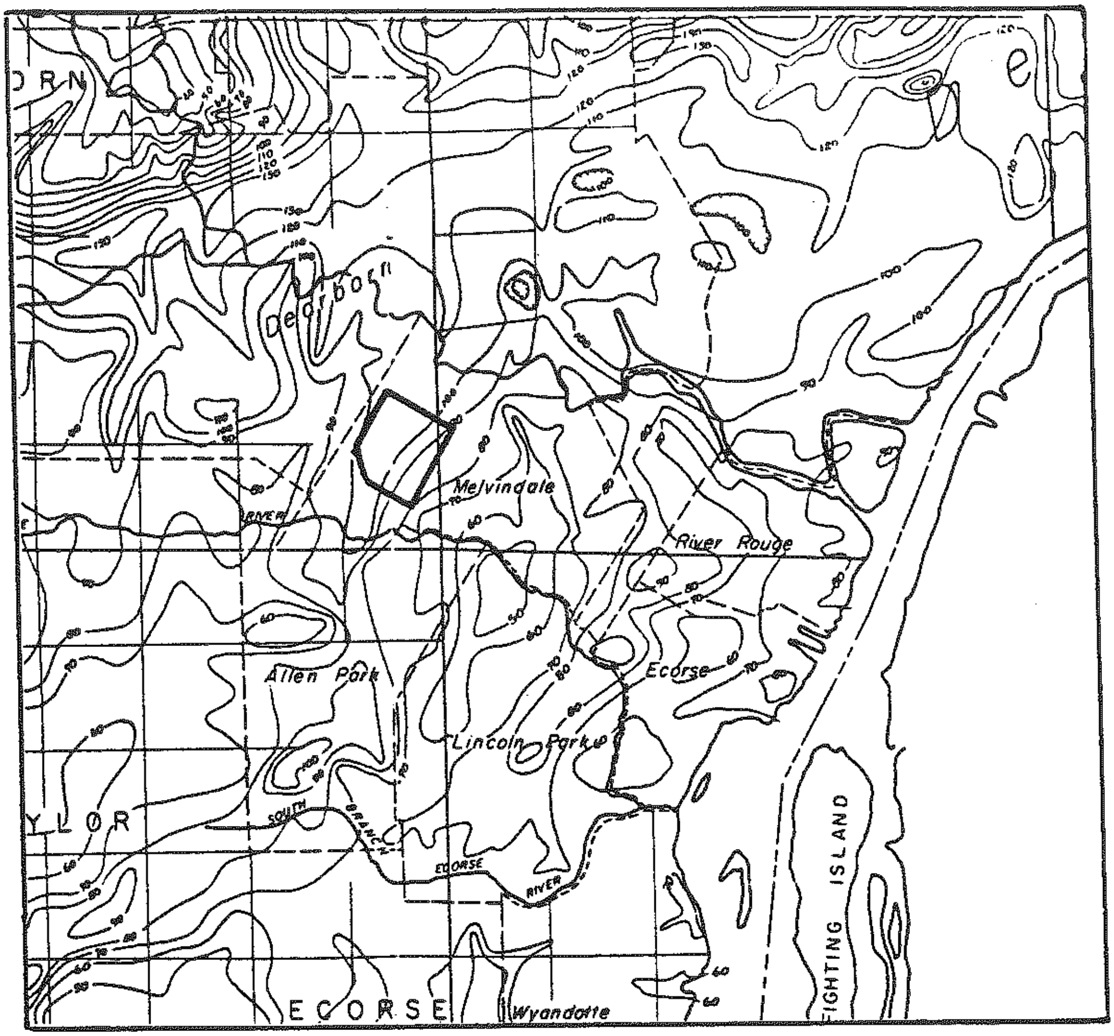
Figure 2



GLACIAL FEATURES OF WAYNE COUNTY, MICHIGAN

LEGEND

- Early Alluvium
- Muck and Peat
- Pleistocene terraced Stream Gravel
- Margin of Water-laid Moraine now veneered with lacustrine sediments; barbs point toward feature
- Margin of Former Delta; barbs point toward feature
- Beach Sand; includes some dune sand
- Glacial Lake Shorelines; dashed line where doubtful or poorly defined
- Clay Ridges
- Moraines
- Ground Moraines
- Kames
- Outwash and Glacial Channels
- Lacustrine and Delta Sand
- Lacustrine Clay
- Lacustrine and Delta Loam
- Boulder Belts



GLACIAL DRIFT THICKNESS MAP OF
WAYNE COUNTY, MICHIGAN

by

ANDREW J. MOZOLA

and

EUGENE I. SMITH

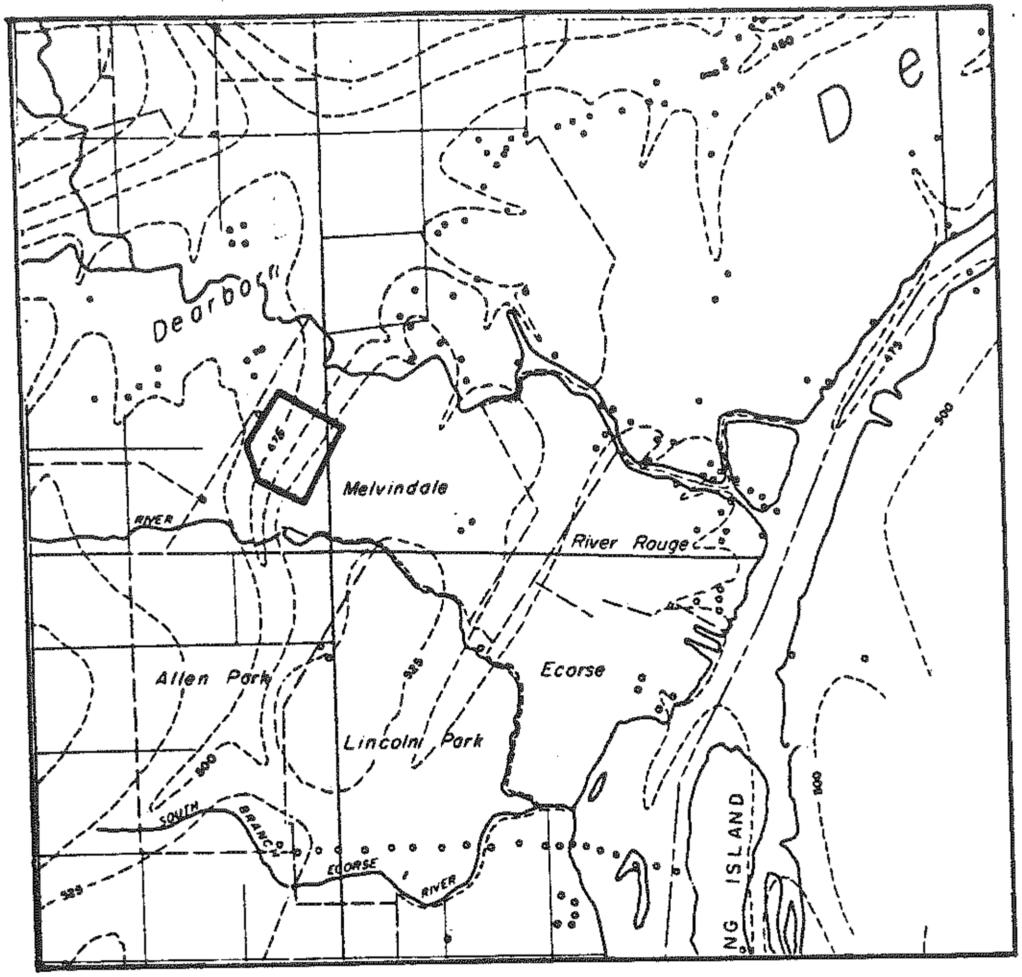
Wayne State University–1967

1 0 1 2 3 4 5 6

Scale in Miles

CONTOUR INTERVAL – 10 FEET

Figure 7



TOPOGRAPHY OF THE BEDROCK SURFACE
OF WAYNE COUNTY, MICHIGAN

by
ANDREW J. MOZOLA
Wayne State University-1967

1 0 1 2 3 4 5 6

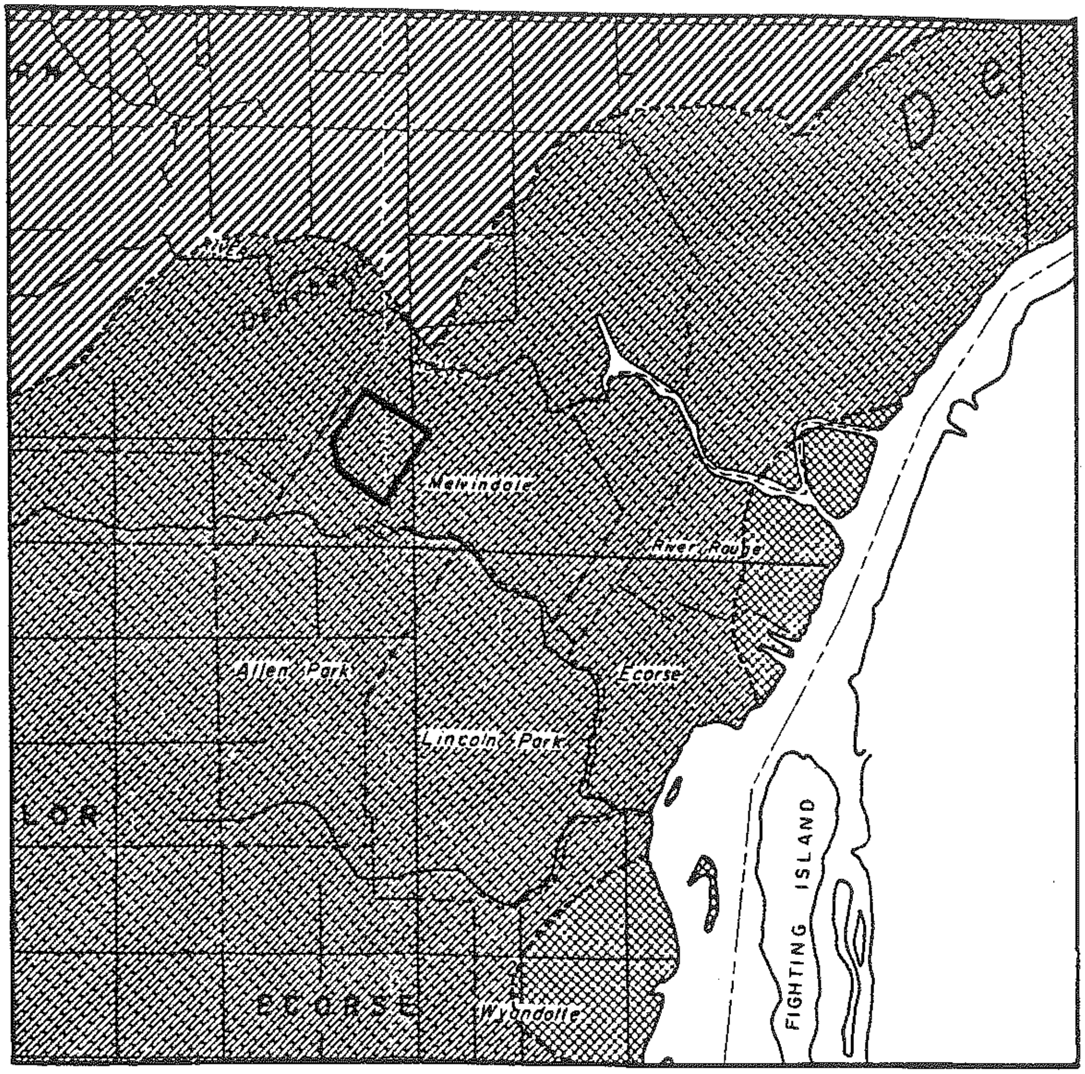
Scale in Miles

CONTOUR INTERVAL- 25 FEET

NOTES

- o *TEST BORINGS AND WELLS REACHING OR PENETRATING BEDROCK.*
- ● *TEST BORINGS AND WELLS NOT REACHING BEDROCK.*
- ◎ *BEDROCK ELEVATIONS FROM SEISMIC DATA.*

Figure 8



LEGEND

Mc	COLDWATER SHALE
Ms	SUNBURY SHALE
Mb	BEREA SANDSTONE
Mbd	BEDFORD SHALE
Da	ANTRIM SHALE
Dt	TRAVERSE GROUP
Dd	DUNDEE LIMESTONE
Ddr	DETROIT RIVER DOLOMITE
Ds	SYLVANIA SANDSTONE

BEDROCK GEOLOGIC MAP OF WAYNE COUNTY, MICHIGAN

1 0 1 2 3 4 5 6

Scale in Miles

After "CENTENNIAL MAP OF SOUTHERN PENNINSULA OF MICHIGAN" with modifications based on new data. Cartography by Don W. Walchak, Department of Geology, Wayne State University, Detroit, Michigan, 1968. Revision of contacts by Andrew J. Mozola.

xc: ~~Bel~~ ~~Al~~ John/Dist. Ken ~~Chuck~~ ~~Jean~~

Original: [illegible]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

De, did EPA consult w/ us regarding this letter before it was sent? Cl

REPLY TO THE ATTENTION OF:
5HE-12

Ben C. Tretheway, Manager
Mining Properties Department
Ford Motor Company
3001 Miller Road
Dearborn, Michigan 48121

Re: Ford Allen Park Clay Mine
Groundwater Monitoring Waiver
MID 980 568 711

Dear Mr. Tretheway:

This letter is in response to the groundwater waiver demonstration for the above-referenced facility. The waiver demonstration was complete on receipt of the revised introductory page dated October 10, 1985, by the United States Environmental Protection Agency (U.S. EPA)

The waiver has been reviewed by the Resource Conservation and Recovery Act (RCRA) Enforcement Section. From our review, we feel that the groundwater monitoring requirements as specified in Subpart F of 40 CFR 265 may be partially waived for the Ford Allen Park Clay Mine facility. This is based on a low potential for migration of hazardous waste or hazardous waste constituents from the facility via the upper-most aquifer to water supply wells or to surface water. The acceptance or denial of a waiver is based primarily on site-specific hydrogeology. A partial waiver was accepted for the above-referenced facility based on the following hydrogeological findings:

1. Lacustrine clay directly underlies the site to a depth of approximately 25 to 80 feet. It is predominantly (CL) soil, 15 to 25% sand, and has a vertical coefficient of permeability ranging from 1.8×10^{-8} to 4.1×10^{-8} cm/s and a horizontal coefficient of permeability ranging from 3.6×10^{-8} to 8.2×10^{-8} cm/s. The clays are saturated with water which appears to be from the underlying aquifer. Horizontal hydraulic gradients within the clay are minimal except in the upper 10 feet, where flow is to the north. Vertical hydraulic gradients are upward.

2. The uppermost aquifer underlies the lacustrine clay. It is a sand layer ranging in thickness from 1 to 6 feet. It contains slightly mineralized water with total dissolved solids of approximately

HAZ.WASTE DIV

1500 mg/l. It is artesian with a piezometric surface several feet above the land surface.

3. Runoff from hazardous waste areas is collected within the cells, sampled, and put into the Detroit sanitary sewer system.

4. There are no groundwater withdrawal wells in any formation within a 3 mile radius of the facility.

Because this letter represents the acceptance of only a partial waiver, some groundwater monitoring must be implemented in order to detect any hazardous constituents that may have entered into the groundwater. An appropriate monitoring plan would be annual sampling and static water level measurements of upgradient wells 5-D and 5-S and downgradient wells 2-D, 2-S, 102-D, 103-D and 104-D for the following waste-specific parameters: cadmium, cyanide (complexed), hexavalent chromium, lead, napthalene, nickel, and phenol. Results from the sampling should be submitted to the U.S. EPA with a short discussion pertaining to the results. Sampling should commence immediately with the results submitted to the U.S. EPA by February 28, 1986.

This letter approves the partial waiving of groundwater monitoring requirements as specified in Subpart F of 40 CFR 265 only and does not endorse or represent support for the waiving of groundwater monitoring requirements of 40 CFR 264 in any way. Any additional information pertaining to the hydrogeology or groundwater quality of the site that becomes available may result in this partial waiver acceptance being reconsidered.

Also note that the complete groundwater waiver demonstration, including the water balance calculation, piezometer study, hydrogeological study, contaminant transport study, and all other exhibits must be kept at the facility (40 CFR 265.90(c)). Please contact Marian Barnes of my staff at (312) 886-7568, if you should have any questions regarding this matter.

Sincerely yours,

Wm. E. Muno

William E. Muno, Chief
RCRA Enforcement Section

cc: A. Howard, MDNR

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS AND GEOLOGISTS
30999 Ten Mile Road • Farmington Hills, Michigan 48024 • (313) 471-0750

JEROME C NEYER P E
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GERALD J HILL P E
STEVEN W HUNT P E
HARRY R PRICE P E
JAMES M SHOVELY P E
J M SMALLEY P E
KEITH M SWAFFAR P E

March 29, 1985
Project No. 84185 OW

Mr. David S. Miller
Mining Properties Department
Rouge Steel Company
3001 Miller Road
Dearborn, Michigan 48121

RE: Vertical Hydraulic Gradients
Allen Park Clay Mine Landfill

Dear Mr. Miller:

In accordance with your request, we have completed the installation of piezometers and the evaluation of the hydraulic gradients in the natural clay deposit at the Allen Park Clay Mine Landfill. This work was performed in general accordance with our proposal, dated October 22, 1984, and was authorized by you on January 16, 1985. The information, evaluations and conclusions presented herein have been prepared according to generally accepted geotechnical engineering practices and are provided for the exclusive use of the Ford Motor Company, the U.S. Environmental Protection Agency and the Michigan Department of Natural Resources.

BACKGROUND

The general subsoil profile at the site consists of an upper sand, replaced by fill in some areas, underlain by an extensive silty clay deposit which is, in turn, underlain by a lower sand deposit. This lower sand is sometimes found in conjunction with a highly overconsolidated clayey silt deposit, locally termed hardpan. On the basis of the information obtained during the piezometer installation described herein as well as information presented in a report entitled Hydrogeologic Study-Allen Park Clay Mine, by Michigan Testing Engineers (MTE) and dated November 24, 1981, the thickness of these deposits at the location of the three piezometer nest locations can be described as follows:

- Upper Sands - 3 to 7 feet
- Silty Clay - 65 to 70 feet
- Lower Sands - 3 to 6 feet or more

Groundwater levels have been monitored in the upper and lower sands at the site for at least several years (MTE, 1981). These levels indicate that there is a saturated zone in the upper sand, at least on a seasonal basis. The lower sand contains groundwater under artesian pressure, with piezometric levels at or above the ground surface.

Based upon these data, an upward hydraulic flow gradient has been considered by Rouge Steel Company (in permit submittals) to exist at the site. In other words, groundwater apparently flows from the lower sand upward through the clay deposit to the upper sand. Michigan Department of Natural Resources (MDNR) staff have requested that the existence and direction of natural flow gradients within the clay deposit at the site be confirmed with the use of three piezometer nests wherein piezometric pressures at various depths within the clay deposit would be monitored. Because of this request by MDNR staff, Rouge Steel Company retained Neyer, Tiseo & Hindo, Ltd. (NTH) to install and monitor such a piezometer system.

PIEZOMETER SYSTEM

The piezometer system consists of a piezometer installed near the top, middle and base of the natural clay deposit beneath the site. This grouping of three, considered a "nest", has been duplicated at three different locations on the site, resulting in a total of nine piezometers set in the clay deposit. Each nest is located near an existing monitoring well pair, consisting of a shallow and a deep well. Their approximate locations are presented on the Piezometer Nest Location Plan, Plate 1. Each piezometer is identified first by the number of the well pair and second by position in the nest, 1 indicating deep with 3 being shallow.

The drilling and piezometer installation was performed by West Michigan Drilling during the period of February 13 through February 20, 1985 under the full-time supervision of personnel from NTH. Ground surface and top of casing elevations have been provided by Rouge Steel Company.

A trailer-mounted CME-55 drilling rig with 8-inch diameter hollow-stem augers was used to drill the piezometer holes. A limited number of soil samples were recovered to identify the depth of the upper sand/clay interface and to verify the soil type at the placement depth. The locations of samples recovered are reported on the logs.

Soil conditions encountered in the test borings were visually evaluated in the field and are presented on the individual Logs of Piezometer Installation, Figures 1 through 9. In addition, the logs present data relating to drilling methods, personnel involved and grouting procedures. The stratification lines shown on the logs represent the approximate boundary between soil types but the transition may be gradual. General Notes describing the nomenclature used in the logs are also included herein as Exhibit 1.

The general procedure for the piezometer installation involved drilling down to a depth of one foot below the desired tip

placement elevation. A sample was taken at this point to verify the characteristics of the soil within which the piezometer was to be installed. The augers were then removed until only ten or fifteen feet remained in the hole. Silica sand was then poured into the bottom of the hole until the sand backfill reached the desired tip elevation. The piezometer was inserted and an additional two to three feet of the hole was filled with sand. Bentonite pellets were placed to provide a seal, in some cases, and the hole was then grouted to the ground surface with non-shrinking cement grout. A four foot section of 5-inch diameter Schedule 40 PVC casing was positioned at the ground surface to protect the leads of the piezometers.

The piezometers are pore-pressure transducers which convert fluid pressure in the soil to pneumatic pressure which can be monitored at the ground surface using a compressed nitrogen source. They are a pneumatic, diaphragm type with a Norton Alundum filter and triple tubing and are manufactured by SINCO, Model No. 514178.

PIEZOMETRIC DATA EVALUATION

The piezometers and associated well pairs were monitored by personnel from NTH on several occasions. This data is presented in Table 1. The data obtained on the last date shown in Table 1 indicates that the pore water pressures adjacent to each piezometer had achieved near-equilibrium or stability after having been temporarily disturbed during drilling for the piezometer installations. This latter set of data has therefore been chosen for presentation in Plates 2 through 4, entitled Piezometric Data Illustration, Nest No. 2, 5 and 10, respectively. Note that in preparation of these illustrations, the shallow wells have been depicted as yielding water levels representative of the water levels in the upper sand even though they were completed in clay. This is considered appropriate because the available data (MTE, 1981) on these shallow wells indicates that they were constructed with a sand-filled borehole annulus, thus effecting a hydraulic connection between the upper sand and the shallow well screens. In addition, the upper sand and lower granular deposits were assumed to possess little or no vertical hydraulic gradient.

Evaluation of the data presented on Plates 2 through 4 yields several important observations:

- A pronounced upward hydraulic gradient is apparent at all three locations.

TABLE 1: PIEZOMETRIC ELEVATIONS
ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

Date	2-1	2-2	2-3	MW-2 Deep	MW-2 Shallow	5-1	5-2	5-3	MW-5 Deep	MW-5 Shallow	10-1	10-2	10-3	MW-10 Deep	MW-10 Shallow
[illegible]-10-85	-	-	-			540.2	580.0	587.1			-	-	-		
2-10-85	-	-	-			563.4	584.1	590.5			-	-	-		
[illegible]	-	-	-			568.9	584.6	592.9			541.5	589.4	-		
[illegible]-20-85	570.2	586.9	-			573.3	586.9	591.2			554.0	590.3	582.2		
[illegible]-21-85	589.6	588.3	583.3			575.9	586.9	591.2			565.5	590.3	583.6		
[illegible]	-	-	-			587.4	589.3	*			-	-	-		
[illegible]	583.7	591.0	585.5		586.3	589.1	590.5	591.7		596.5	594.2	590.2	587.0	594.3	590.0
[illegible]	584.4	591.0	585.0			592.5	590.2	592.4			595.1	591.1	587.0		
[illegible]-11-85	585.1	590.7	586.5	599.7	586.7	594.1	590.9	591.9	604.2	596.4	595.3	591.1	587.4	594.4	589.9
[illegible]	585.3	591.0	586.7		580.6	596.3	593.2	591.7		595.7	595.5	591.1	587.4	594.6	588.0

*Ran out of N_2

- The upward flow gradient in the clay deposit is very nearly linear, suggesting a somewhat homogeneous deposit, at least with regard to vertical hydraulic conductivity. Similarly, all three locations yield upward hydraulic gradients that are of the same general magnitude.

- There appears to be some discontinuity of the hydraulic gradient with regard to piezometric levels in the upper and lower sand, most probably due to seasonal variability.

To elaborate, it can be seen that the estimated upward hydraulic gradient in Nest Nos. 2, 5 and 10 are 0.21, 0.11 and 0.20 ft./ft., respectively, based solely upon the piezometric data in the clay deposit. If we estimate the upward hydraulic gradient on the basis of the piezometric levels in the upper and lower sand deposits, these values are 0.19, 0.12, and 0.10, respectively. The differences between these two sets of hydraulic gradient data may be related to higher than normal water levels in the upper sand due to the seasonal weather conditions (snowmelt) which preceded the acquisition of the subject data. Hence, the hydraulic gradients based upon the piezometric data in the clay deposit most probably reflect the "normal" conditions, since these piezometric levels should be far less responsive to seasonal variations.

The deep well at Nest No. 10 is yielding water levels lower than expected on the basis of the piezometric levels observed in the clay. When originally installed in March, 1978, this well was reported (MTE, 1981) to exhibit piezometric levels near Elevation 602. This would correspond very well with the piezometric data in the clay. According to information from Rouge Steel Company, the piezometric level in this well dropped suddenly in 1982. The well was subsequently damaged in the spring of 1983. Hence, it is impossible to ascertain from available data whether the piezometric level currently observed in this well is erroneous.

The hydraulic gradients depicted on Plates 2 through 4 can be used to estimate a piezometric level at the same elevation in each location. Choosing Elevation 560 for instance, such an estimation yields piezometric levels of 589.2, 592.6, and 589.7 at Nest Nos. 2, 5, and 10, respectively. This suggests that a very gradual horizontal hydraulic gradient may exist within the clay deposit, at least with respect to the date of piezometer monitoring. The direction of this gradient is essentially northward. However, it should be noted that the possible velocity of flow and/or quantity of flow in a horizontal

direction within the clay deposit due to this gradient would be very small, especially in comparison to vertical migration or horizontal flow in the underlying granular deposit. It should also be noted that the past excavation and filling activities on the site have, or will, distort horizontal and vertical flow conditions in the clay deposit in the immediate vicinity of the excavations.

In a report entitled "Containment Integrity of Allen Park Clay Mine/Landfill" (July, 1983), Dr. Donald H. Gray discussed the upward hydraulic gradients at the subject site, with particular emphasis on the potential for downward contaminant migration despite upward hydraulic gradients. In that report, he evaluated such potential contaminant migration under upward hydraulic gradients imposed by the landfill excavation. He went on to discuss a "worst case" where the upward gradient would be approximately 0.3 ft./ft. if leachate levels in the landfill were allowed to reach the ground surface.

The data presented herein indicate upward hydraulic gradients through the native, undisturbed clay deposit to be roughly 0.1 to 0.2 ft./ft. If the thickness of the clay deposit is reduced due to excavation and leachate levels within the landfill are precluded from exceeding the water level in the sand at the surface of the site, then the imposed upward gradients will approximate or exceed his "worst case", i.e. his lowest gradient. Hence, maintenance of leachate collection systems will help assure that vertical flow beneath the landfill cells is upward, with induced hydraulic gradients similar to those presented by Dr. Gray (1983).

If you have any questions, please do not hesitate to contact us.

Very truly yours,

NEYER, TISEO & HINDO, LTD.

Liane J. Shekter

Liane J. Shekter

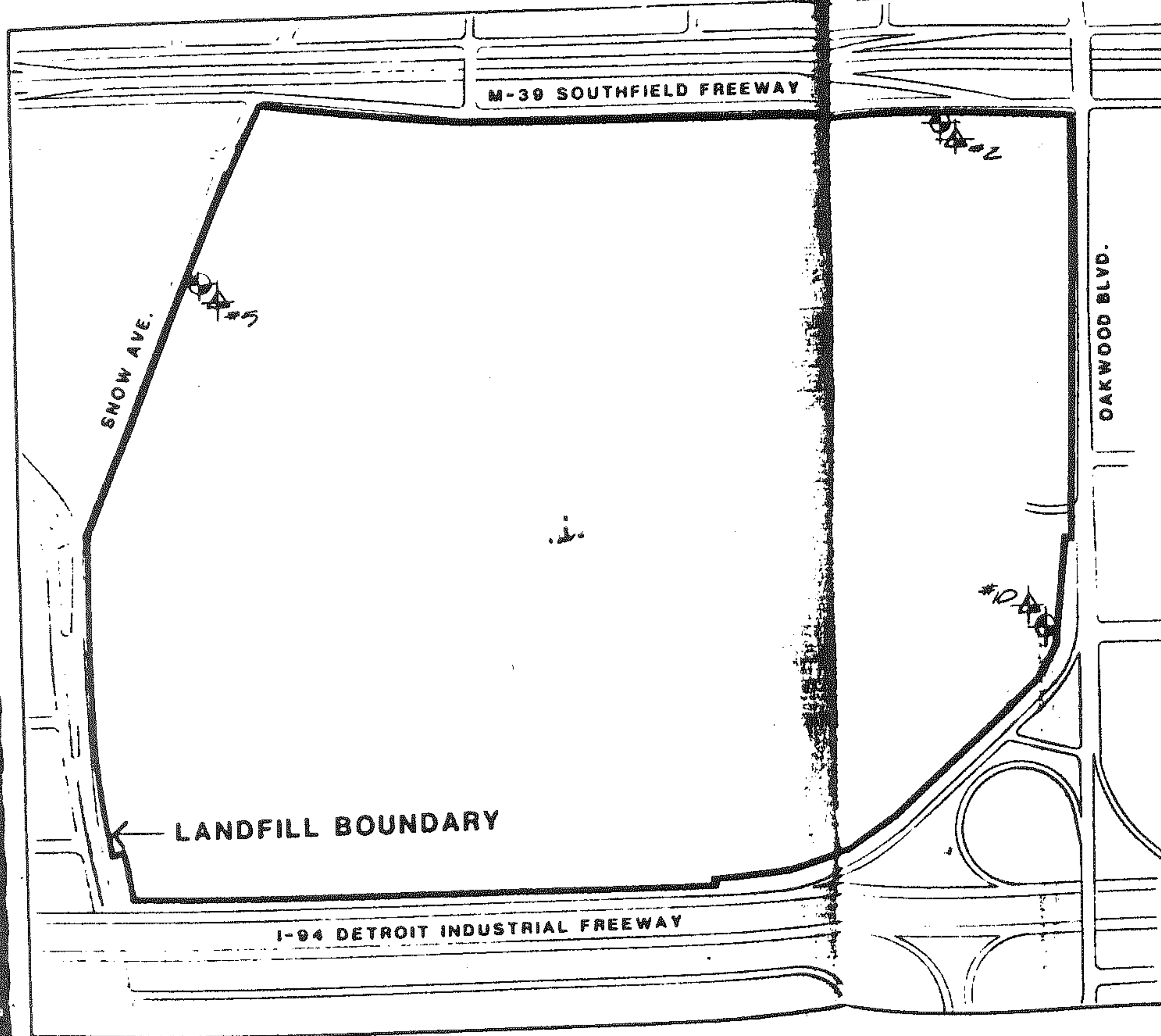
Wayne R. Bergstrom

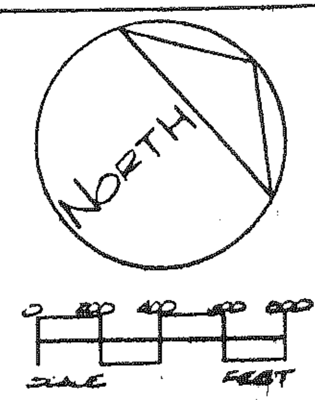
Wayne R. Bergstrom, P.E.

LJS/WRB/pp
Attachments

NTH NEYER, TISEO & HINDO, LTD.

LIST OF PLATES AND FIGURES





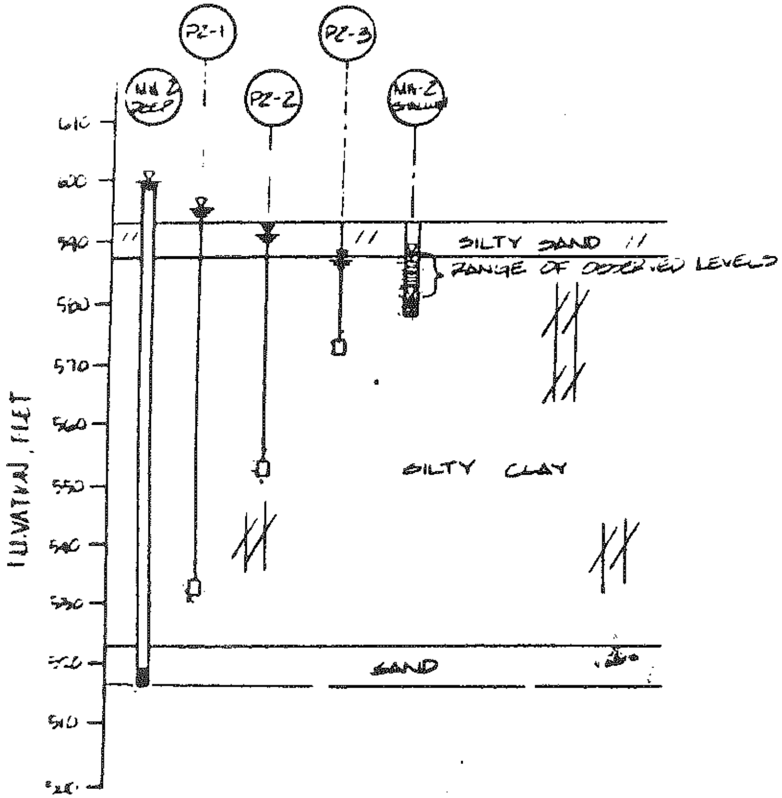
LEGEND:

PIEZOMETER NEST (THREE PIEZOMETERS) INSTALLED BY WEST MICHIGAN DRILLING INC FROM FEBRUARY 3 TO FEBRUARY 20 198_ UNDER THE SUPERVISION OF NEYER, TISEO & HINDO LTD LOCATION SHOWN IS APPROXIMATE.

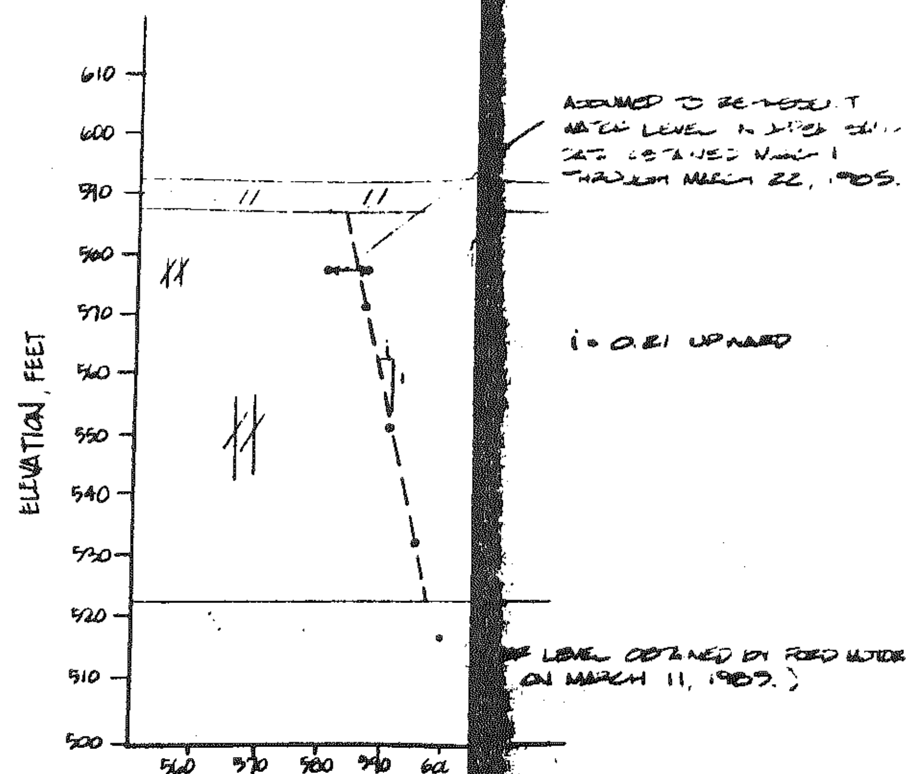
MONITORING WELL PAIR - INSTALLED PREVIOUSLY BY MICHIGAN TESTING ENGINEERS INC LOCATION DETERMINED BY OTHERS.

PIEZOMETER NEST LOCATION PLAN		
ALLEN PARK CLAY MINE LANDFILL FORD MOTOR COMPANY ALLEN PARK, MICHIGAN		
NTH NEYER, TISEO & HINDO, LTD. CONSULTING ENGINEERS TEN MILE RD. FARMINGTON HILLS, MI 48024		
PROJECT NO	DRAWN BY JEK	DATE 3-20-8_
SCALE	CHECKED BY RB3	SHEET OF

PLATE 1



SCHEMATIC OF PIEZOMETRIC DATA



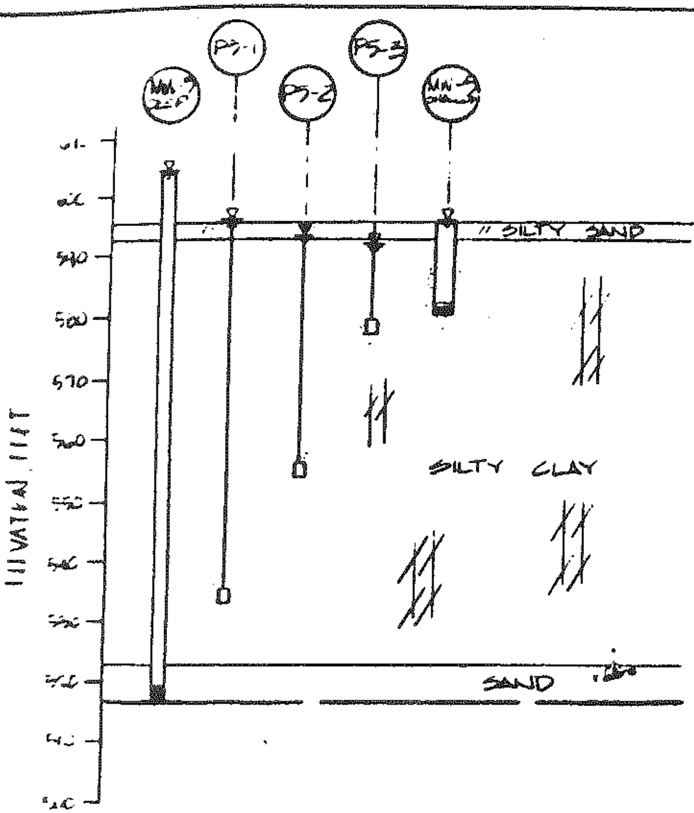
PIEZOMETRIC (WATER LEVEL) [illegible]ATION, FEET

NOTES:

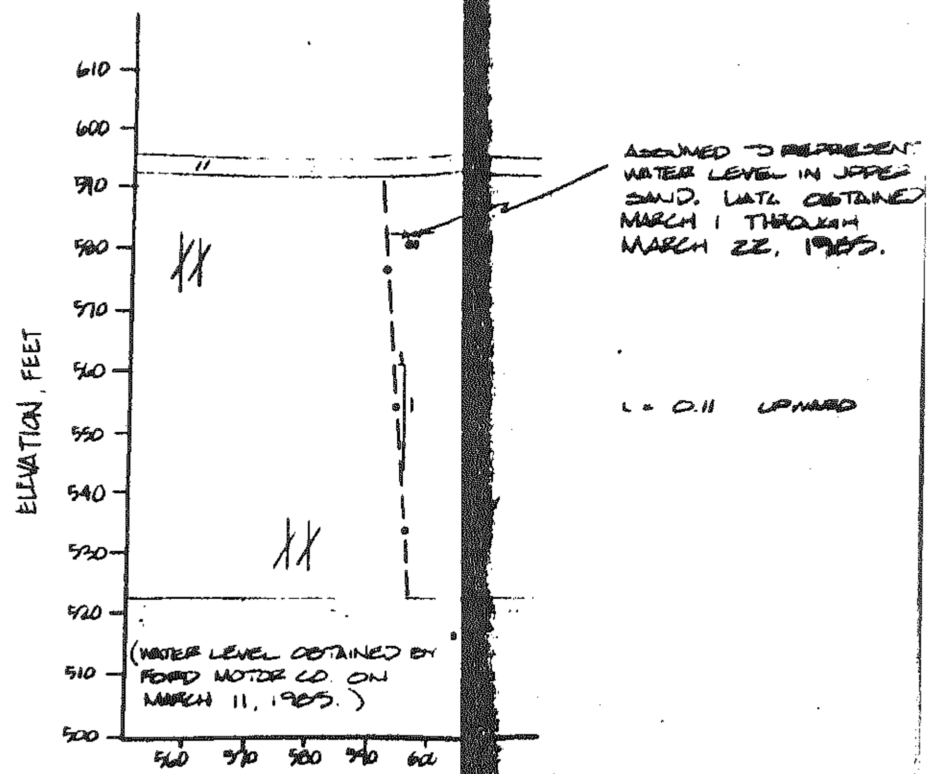
1. PIEZOMETRIC DATA OBTAINED BY NEYER TISEO & HINDO, LTD. ON MARCH 22, 1985, EXCEPT AS NOTED.
2. PIEZOMETERS (DENOTED BY "P") WERE INSTALLED BY NEYER, TISEO & HINDO, LTD. WELLS WERE INSTALLED BY OTHERS.
3. HORIZONTAL POSITIONS OF WELLS AND PIEZOMETERS IN SCHEMATIC AT LEFT ARE FOR ILLUSTRATION ONLY.
4. SUBSURFACE PROFILE IS BASED UPON DRILLING RECORDS AND IS GENERALIZED.

PIEZO[illegible]RIC DATA ILLUSTRATION NEST NO 2	
ALL[illegible] PARK CLAY MINE LANDFILL FOR[illegible] MOTOR COMPANY [illegible] PARK, MICHIGAN	
N[illegible]ER, TISEO & HINDO, LTD. C[illegible]ULTING ENGINEERS [illegible] MILE RD. · FARMINGTON HILLS, MI 48024	
PROJECT NO [illegible]	DRAWN BY JFL
SCALE: N[illegible]	CHECKED BY MEB
DATE [illegible]	SHEET 1 OF 1

PLATE 2



SCHEMATIC OF PIEZOMETRIC DATA



PIEZOMETRIC (WATER LEVEL) ELEVATION, FEET

NOTES:

1. PIEZOMETRIC DATA OBTAINED BY NEYER TISEO & HINDO, LTD. ON MARCH 22, 1985, EXCEPT AS NOTED.
2. PIEZOMETERS (DENOTED BY "P") WERE INSTALLED BY NEYER, TISEO & HINDO, LTD. WELLS WERE INSTALLED BY OTHERS.
3. HORIZONTAL POSITIONS OF WELLS AND PIEZOMETERS IN SCHEMATIC AT LEFT ARE FOR ILLUSTRATION ONLY.
4. SUBSURFACE PROFILE IS BASED UPON DRILLING RECORDS AND IS GENERALIZED

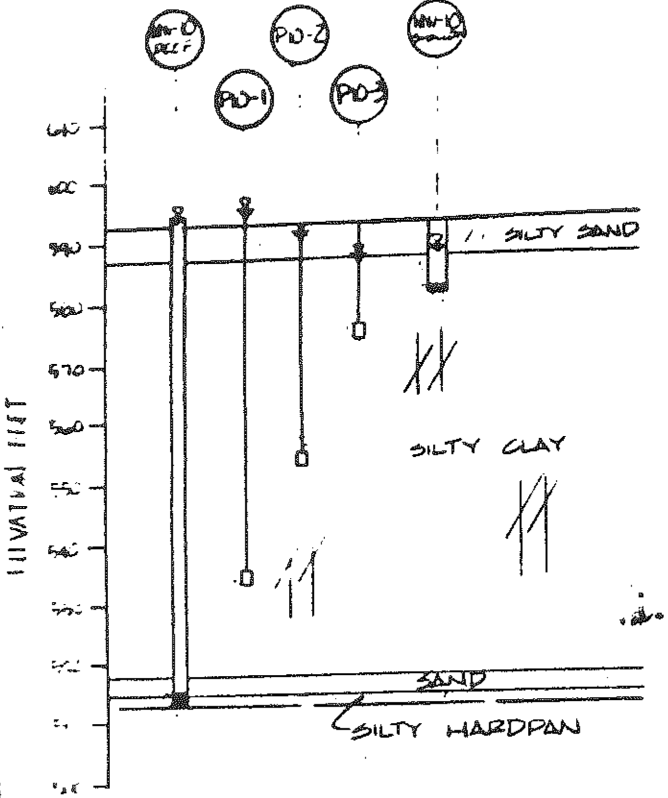
PIEZOMETRIC DATA ILLUSTRATION NEST No 3

ALLEN PARK CLAY MINE LANDFILL
FORD MOTOR COMPANY
ALLEN PARK, MICHIGAN

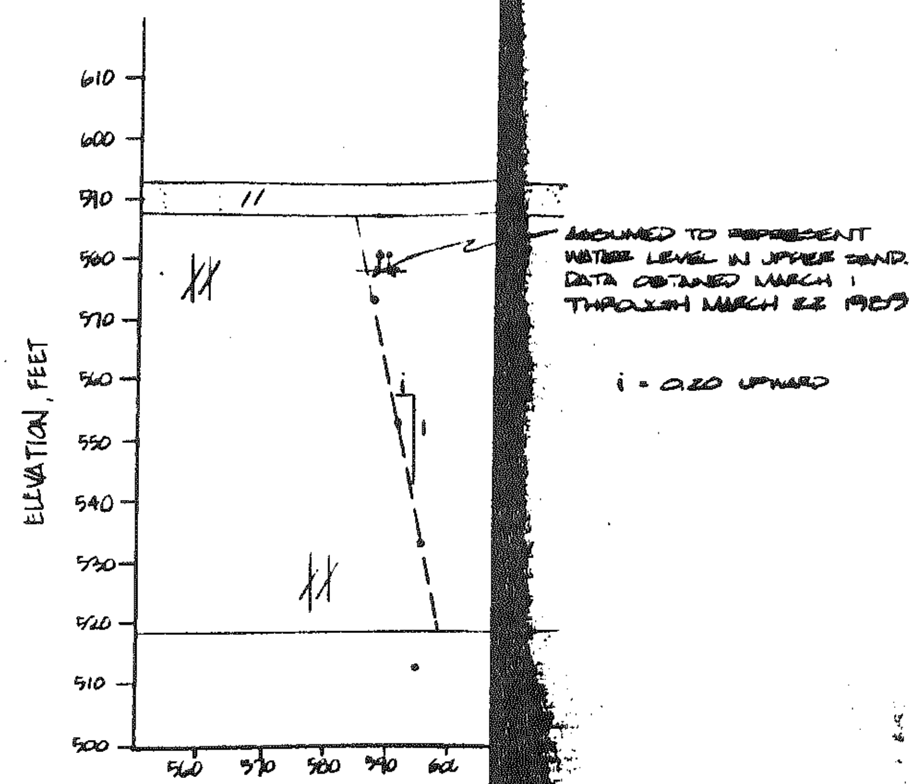
NTH NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS
30 TEN MILE RD. · FARMINGTON HILLS, MI 48024

PROJECT NO	DRAWN BY: JRK	DATE 5-20-85
SCALE: NONE	CHECKED BY: NFD	SHEET 1 OF 1

PLATE 3



SCHEMATIC OF PIEZOMETRIC DATA



PIEZOMETRIC (WATER LEVEL) ... TION, FEET

NOTES

1. PIEZOMETRIC DATA OBTAINED BY NEYER TISEO & HINDO, LTD. ON MARCH 22, 1985.
2. PIEZOMETERS (DENOTED BY "P") WERE INSTALLED BY NEYER, TISEO & HINDO, LTD. WELLS WERE INSTALLED BY OTHERS.
3. HORIZONTAL ... TIONS OF WELLS AND PIEZO... IN SCHEMATIC AT LEFT ARE ... STRATION ONLY.
4. SUBSURFACE ... FILE IS BASED UPON DRILLING ... AND IS GENERALIZED

PIEZO... DATA ILLUSTRATION NEST No. 10	
ALL... CLAY MINE LANDFILL FOR... COMPANY ... PARK, MICHIGAN	
NTH N..., TISEO & HINDO, LTD. C... ING ENGINEERS 30... MILE RD. FARMINGTON HILLS, MI ...	
PROJECT NO. ...	DRAWN BY: ... DATE: ...
SCALE: NONE	CHECKED BY: ... SHEET: 1 OF 1

PLATE 4

NEYER, TISEO & HINDO, LTD.

GENERAL NOTES

TERMINOLOGY

Unless otherwise noted, all terms utilized herein refer to the Standard Definitions presented in ASTM D 653.

PARTICLE SIZES

Boulders		-	Greater than 12 inches (305mm)
Cobbles		-	3 inches (76.2mm) to 12 inches (305mm)
Gravel	Coarse	-	3/4 inches (19.05mm) to 3 inches (76.2mm)
	Fine	-	No. 4 - 3/16 inches (4.75mm) to 3/4 inches (19.05mm)
Sand	Coarse	-	No. 10 (2.00mm) to No. 4 (4.75mm)
	Medium	-	No. 40 (0.425mm) to No. 10 (2.00mm)
	Fine	-	No. 200 (0.074mm) to No. 40 (0.425mm)
Silt		-	0.005mm to 0.074mm
Clay		-	Less than 0.005mm

COHESIONLESS SOILS

Classification

The major soil constituent is the principal noun, i.e. sand, silt, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)	Minor Constituents (percent by weight)
Trace - 1 to 12%	Trace - 1 to 12%
Adjective - 12 to 35% (clayey, silty, etc.)	Little - 12 to 23%
And - Over 35%	Some - 23 to 33%

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0-15	0-4
Loose	16-35	5-10
Medium Compact	36-65	11-30
Compact	66-85	31-50
Very Compact	86-100	Over 50

Relative Density of Cohesionless Soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier; i.e., silty clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohensionless soils; i.e., silty clay, trace of sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)	Appromixate Range of (N)
Very Soft	Below 500	0-2
Soft	500-1000	3-4
Medium	1000-2000	5-8
Stiff	2000-4000	9-15
Very Stiff	4000-8000	16-30
Hard	8000-16000	31-50
Very Hard	Over 16000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

SAMPLE DESIGNATIONS

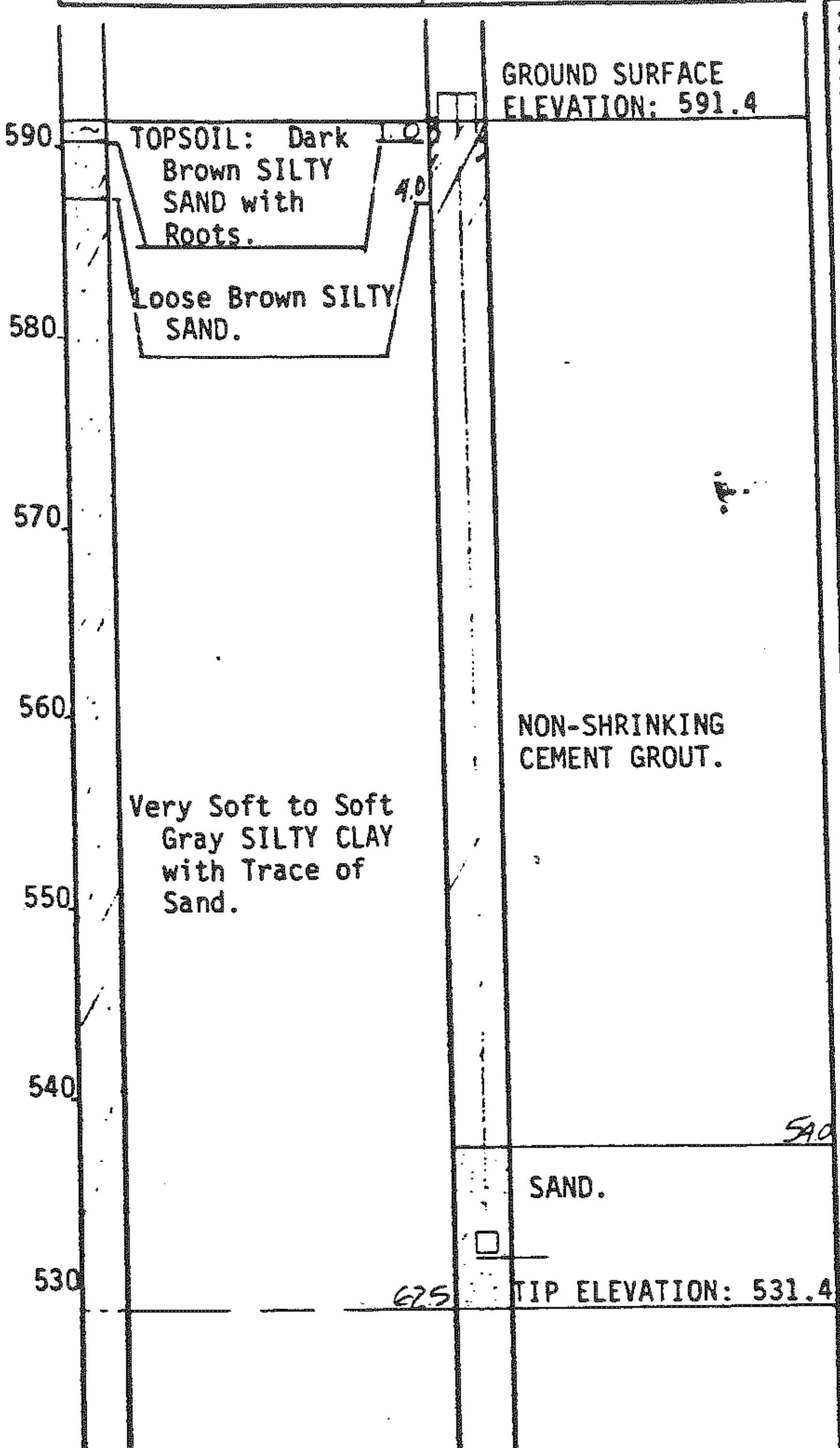
AS - Auger Sample - Directly from auger flight.
BS - Miscellaneous Samples - Bottle or Bag.
S - Split Spoon Sample with Liner Insert - ASTM D 1586
LS - Liner Sample S with liner insert 3 inches in length.
ST - Shelby Tube Sample - 3 inch diameter unless otherwise noted.
PS - Piston Sample - 3 inch diameter unless otherwise noted.
RC - Rock Core - NX core unless otherwise noted.

STANDARD PENETRATION TEST (ASTM D 1586) - A 2.0" outside-diameter, 1-3/8" inside-diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE | SCHEMATIC



GROUNDWATER DATA

DATE	PIEZO-METRIC ELEV. (FEET)	COMMENTS
2-20-85	578.2	
2-21-85	589.6	
3-01-85	593.7	
3-08-85	594.4	
3-11-85	595.1	
3-22-85	595.3	

STARTED: 2-19-85
COMPLETED: 2-19-85
INSPECTOR: A. Al-Saati
DRILLER: D. Klitz
CONTRACTOR: West Michigan Drilling
EQUIPMENT: Trailer mounted CME-55
PIEZOMETER TYPE: Pneumatic operated SINCO Model No. 514178

NOTES:

1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 60.0 feet below the ground surface.
3. Drilling utilized 8-inch diameter hollow-stem augers.
4. Samples were recovered from depths of 2.5 ft, 5.0 ft and 62.5 ft.

NOTES - Continued

5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS
38000 TEN MILE RD., FARMINGTON HILLS, MI 48024

PIEZOMETER NO. Z-1

ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

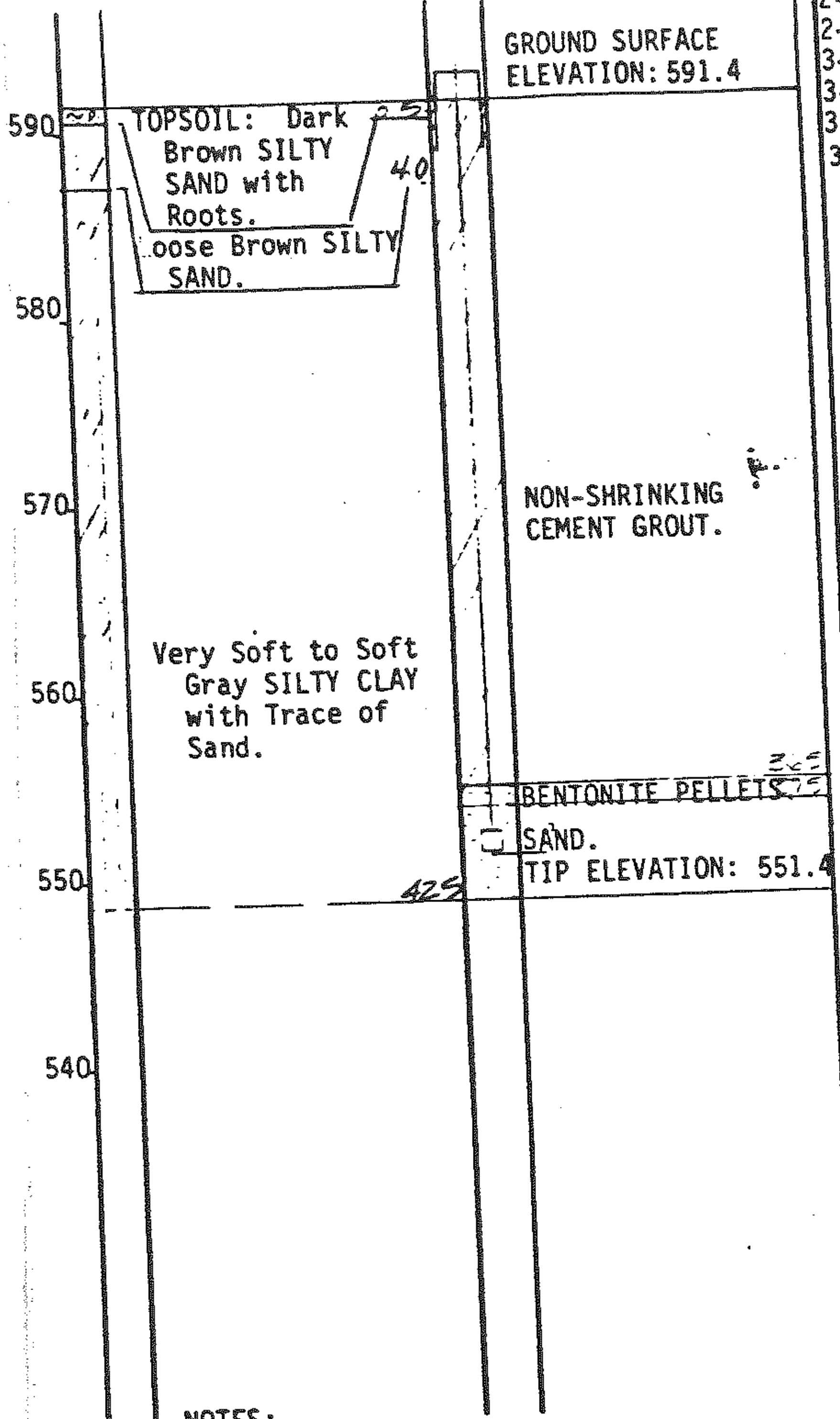
APPROVED BY: LJS | DATE: 3-8-85

84185 OH | FIGURE NO.

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC



GROUNDWATER DATA

DATE	PIEZO-METRIC ELEV. (FEET)	COMMENTS
2-20-85	586.9	
2-21-85	588.3	
3-01-85	591.0	
3-08-85	591.0	
3-11-85	590.7	
3-22-85	591.0	

STARTED: 2-19-85
COMPLETED: 2-19-85
INSPECTOR: A. Al-Saati
DRILLER: D. Klitz
CONTRACTOR: West Michigan Drilling
EQUIPMENT: Trailer mounted CME-55
PIEZOMETER TYPE: Pneumatic operated SINCO Model No. 514178

NOTES:
1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 40.0 feet below the ground surface.
3. Drilling utilized 8-inch diameter hollow-stem augers.
4. Samples were recovered from depths of 2.5 ft., 5.0 ft. and 42.5 ft.

NOTES - Continued
5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

PIEZOMETER No. Z-2

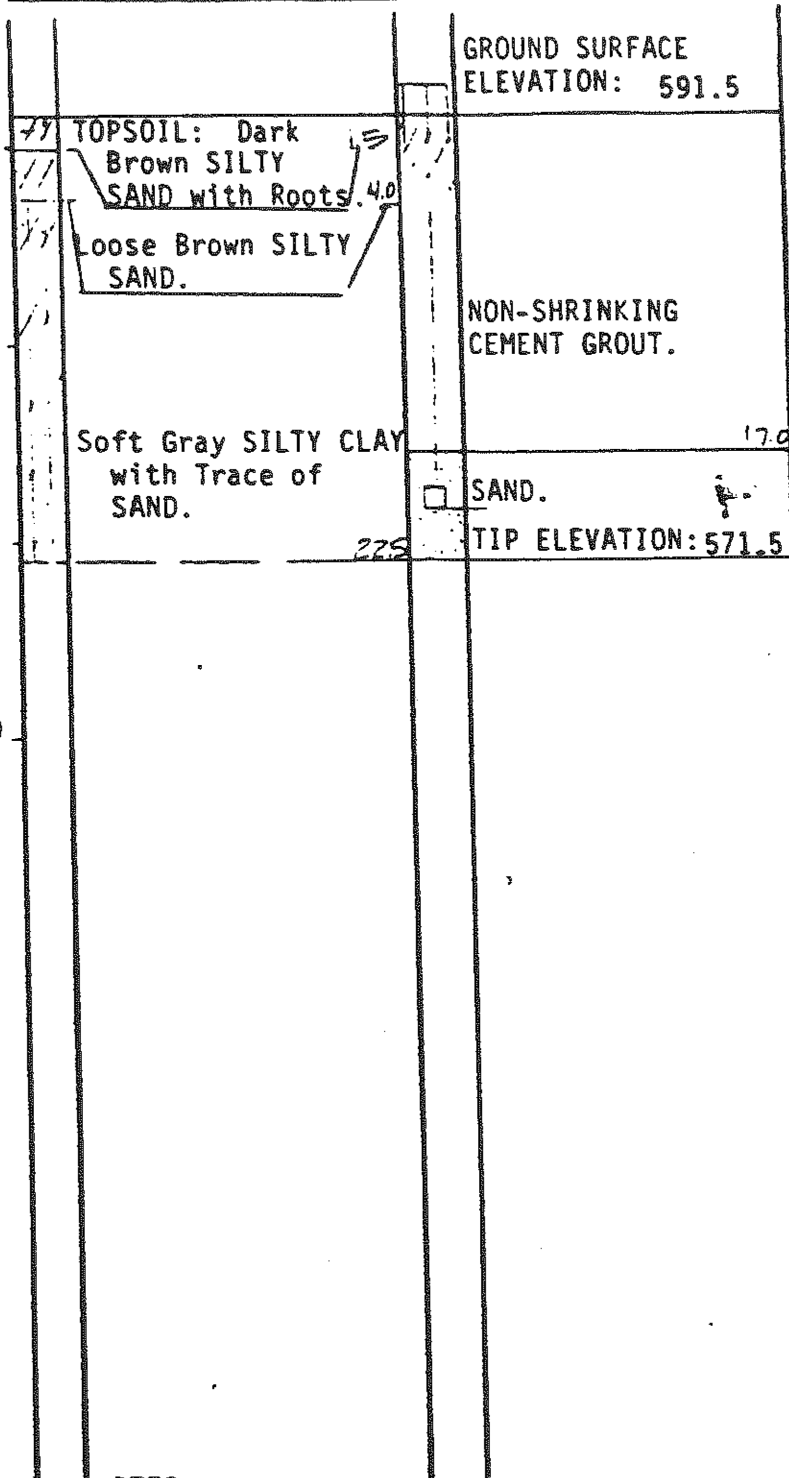
ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

APPROVED BY: LJS | DATE: 3-8-85
PROJECT NO. 84185 OW | FIGURE NO. 2

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE | SCHEMATIC



GROUNDWATER DATA

DATE	PIEZO-METRIC ELEV. (FEET)	COMMENTS
2-21-85	583.3	
3-01-85	585.5	
3-08-85	585.8	
3-11-85	586.5	
3-22-85	586.7	

STARTED:	2-20-85
COMPLETED:	2-20-85
INSPECTOR:	A. Al-Saati
DRILLER:	D. Klitz
CONTRACTOR:	West Michigan Drilling
EQUIPMENT:	Trailer mounted CME-55
PIEZOMETER TYPE:	Pneumatic operated SINCO Model No. 514178

NOTES:
1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 20.0 feet below the ground surface.
3. Drilling utilized 8-inch diameter hollow-stem augers.
4. Samples were recovered from depths of 5.0 ft. and 22.5 ft.

NOTES - Continued
5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

PIEZOMETER No. 2-3

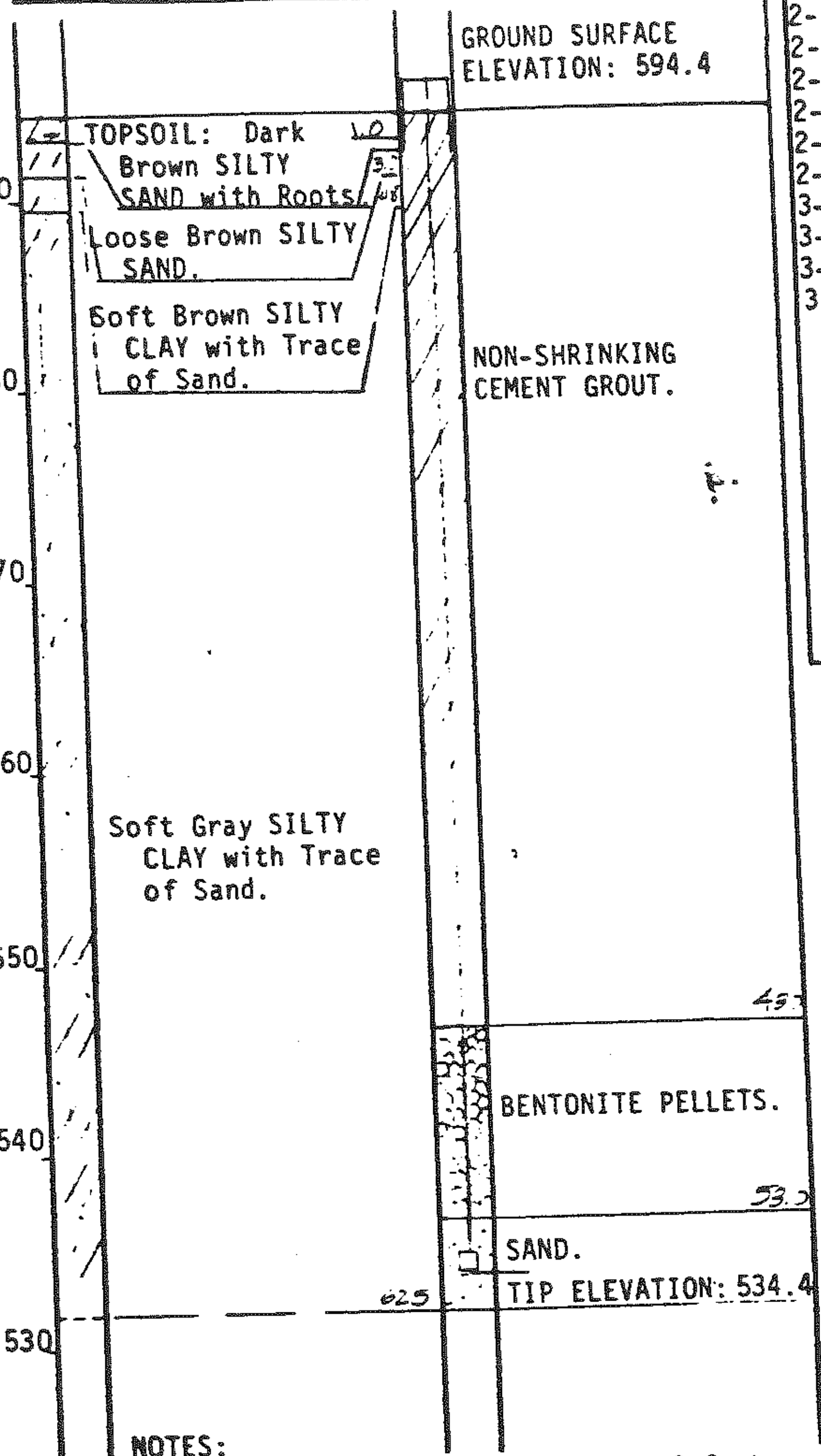
ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

APPROVED BY: LJS | DATE: 3-11-85

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC



GROUNDWATER DATA

DATE	PIEZO-METRIC ELEV. (FEET)	COMMENTS
2-15-85	548.2	
2-18-85	563.4	
2-19-85	568.9	
2-20-85	573.3	
2-21-85	575.9	
2-28-85	587.4	
3-01-85	589.1	
3-08-85	592.5	
3-11-85	594.1	
3-22-85	596.3	

STARTED:	2-13-85
COMPLETED:	2-13-85
INSPECTOR:	L. J. Shekter
DRILLER:	D. Klitz
CONTRACTOR:	West Michigan Drilling
EQUIPMENT:	Trailer mounted CME-55
PIEZOMETER TYPE:	Pneumatic operated SINCO Model No. 514178

NOTES - Continued
5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NOTES:
1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 61.0 feet below the ground surface.
3. Drilling utilized 8-inch diameter hollow-stem augers.
4. Samples were recovered from depths of 2.5 ft., 5.0 ft. and 62.5 ft.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

PIEZOMETER No. 5.1

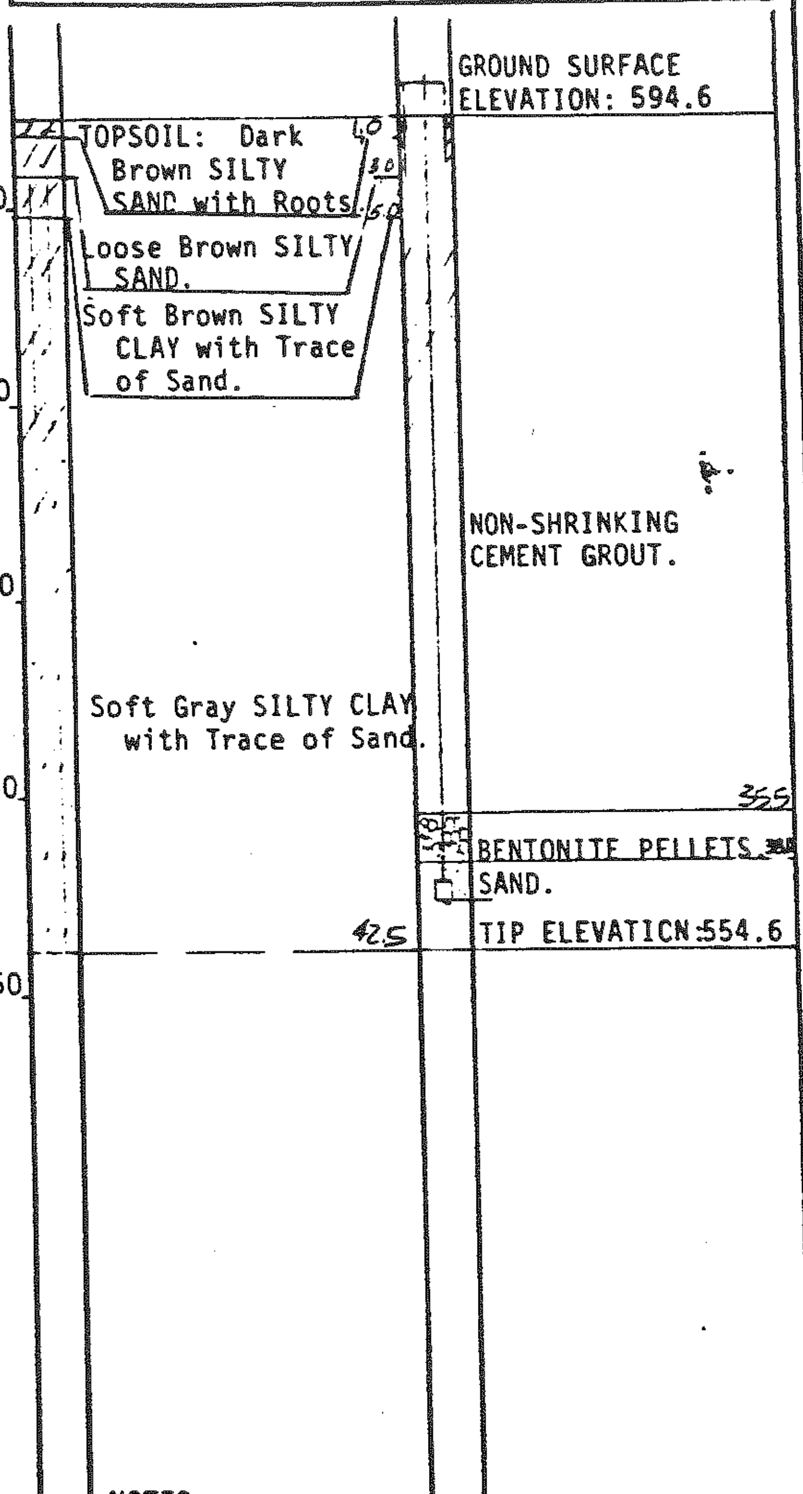
ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

APPROVED BY: LJS | DATE: 3-11-85

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC



GROUNDWATER DATA

DATE	PIEZO-METRIC ELEV. (FEET)	COMMENTS
2-15-85	580.0	
2-18-85	584.1	
2-19-85	584.6	
2-20-85	586.9	
2-21-85	586.9	
2-28-85	589.3	
3-01-85	590.5	
3-08-85	590.2	
3-11-85	590.9	
3-22-85	593.2	

STARTED:	2-14-85
COMPLETED:	2-14-85
INSPECTOR:	L.J. Shekter
DRILLER:	D. Klitz
CONTRACTOR:	West Michigan Drilling
EQUIPMENT:	Trailer mounted CME-55
PIEZOMETER TYPE:	Pneumatic operated SINCO Model No. 514178

NOTES:
1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 40.0 feet below the ground surface.
3. Drilling utilized 8-inch diameter hollow-stem augers.
4. Samples were recovered from depths of

NOTES - Continued
5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

PIEZOMETER NO. 5-2

ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

APPROVED BY: [illegible] DATE: 3-11-85

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE		SCHEMATIC
		GROUND SURFACE ELEVATION: 594.9
TOPSOIL: Dark Brown SILTY SAND with Roots	1.5	
590 — Loose Brown SILTY SAND.	4.5	NON-SHRINKING CEMENT GROUT.
Medium Brown SILTY CLAY with Trace of Sand.	14.0	
580 — Soft to Medium Gray SILTY CLAY with Trace of Sand.	15.4	BENTONITE PELLETS
		SAND.
	20.5	TIP ELEVATION: 577.4
570		

GROUNDWATER DATA

DATE	PIEZOMETRIC ELEV. (FEET)	COMMENTS
2-15-85	587.1	
2-18-85	590.5	
2-19-85	592.9	
2-20-85	591.2	
2-21-85	591.2	
3-01-85	591.7	
3-08-85	592.4	
3-11-85	591.9	
3-22-85	591.7	

STARTED: 2-15-85
COMPLETED: 2-15-85
INSPECTOR: L. J. Shekter
DRILLER: D. Klitz
CONTRACTOR: West Michigan Drilling
EQUIPMENT: Trailer mounted CME-55
PIEZOMETER TYPE: Pneumatic operated SINCO Model No. 514178

NOTES:
1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 17.5 feet below the ground surface.
3. Drilling utilized 8-inch diameter hollow-stem augers.
4. Samples were recovered from depths of 2.5 ft., 5.0 ft. and 20.5 ft.

NOTES - Continued
5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

PIEZOMETER No. 5-3

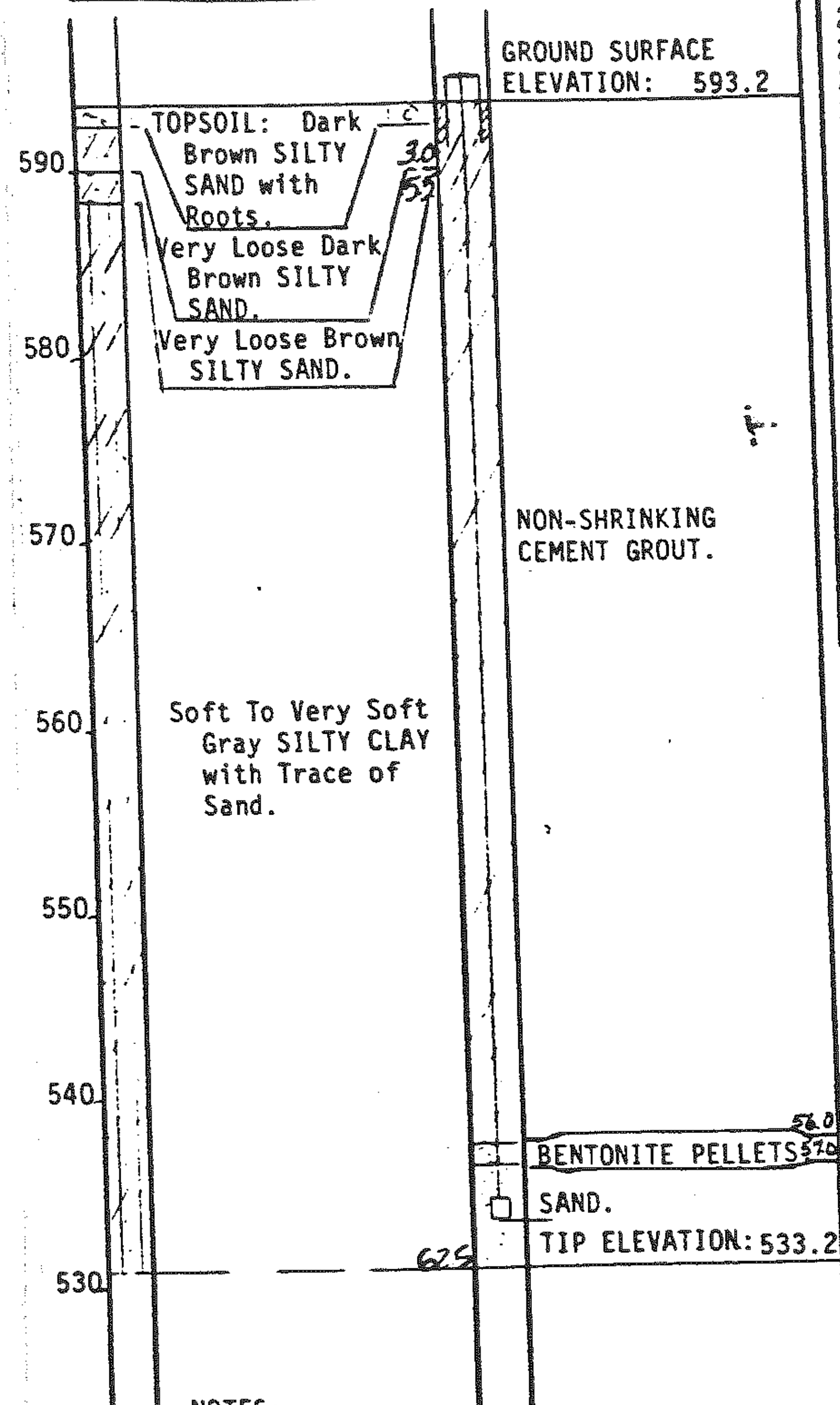
ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

APPROVED BY: LJS
DATE: 3-11-85

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC



GROUNDWATER DATA

DATE	PIEZOMETRIC ELEV. (FEET)	COMMENTS
2-19-85	541.5	
2-20-85	554.0	
2-21-85	565.5	
3-01-85	594.2	
3-08-85	595.1	
3-11-85	595.3	
3-22-85	595.5	

STARTED:	2-18-85
COMPLETED:	2-18-85
INSPECTOR:	A. Al-Saati
DRILLER:	D. Klitz
CONTRACTOR:	West Michigan Drilling
EQUIPMENT:	Trailer mounted CME-55
PIEZOMETER TYPE:	Pneumatic operated SINCO Model No. 514178

NOTES - Continued

5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NOTES:

1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 60.0 feet below the ground surface.
3. Drilling utilized 8-inch diameter hollow-stem augers.
4. Samples were recovered from depths of

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

PIEZOMETER No. 10-1

ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC
	GROUND SURFACE ELEVATION: 592.9
TOPSOIL: Dark Brown SILTY SAND with Roots	
Loose Brown SILTY SAND.	
	NON-SHRINKING CEMENT GROUT.
Soft Gray SILTY CLAY with Trace of Sand.	
	BENTONITE PELLETS
	SAND.
	TIP ELEVATION: 552.9

590
580
570
560
550

GROUNDWATER DATA

DATE	PIEZO-METRIC ELEV. (FEET)	COMMENTS
2-19-85	589.4	
2-20-85	590.3	
2-21-85	590.3	
3-01-85	590.2	
3-08-85	591.1	
3-11-85	591.1	
3-22-85	591.1	

STARTED: 2-18-85
COMPLETED: 2-18-85
INSPECTOR: A. Al-Saati
DRILLER: D. Klitz
CONTRACTOR: West Michigan Drilling
EQUIPMENT: Trailer mounted CME-55
PIEZOMETER TYPE: Pneumatic operated SINCO Model No. 514178

NOTES:
1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 40.0 feet below the ground surface.
3. Drilling utilized 8-inch diamter hollow-stem augers.
4. Samples were recovered from depths of

NOTES - Continued
5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

PIEZOMETER No. 10.2

ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

DATE: 3-11-85

LOG OF PIEZOMETER INSTALLATION

CLASSIFICATIONS BY:
NEYER, TISEO & HINDO, LTD.

GENERALIZED SUBSURFACE PROFILE	SCHEMATIC
	GROUND SURFACE ELEVATION: 593.4
TOPSOIL: Dark Brown SILTY SAND with Roots. (5)	NON-SHRINKING CEMENT GROUT.
Loose Brown SILTY SAND. (5.5)	
Soft Gray SILTY CLAY with Trace of Sand. (22.5)	SAND. (5.0)
	TIP ELEVATION: 573.4

Elevation scale: 90, 80, 70

GROUNDWATER DATA

DATE	PIEZOMETRIC ELEV. (FEET)	COMMENTS
2-20-85	582.2	
2-21-85	583.6	
3-01-85	587.0	
3-08-85	587.0	
3-11-85	587.4	
3-22-85	587.4	

STARTED: 2-19-85
COMPLETED: 2-19-85
INSPECTOR: A. Al-Saati
DRILLER: D. Klitz
CONTRACTOR: West Michigan Drilling
EQUIPMENT: Trailer mounted CME-55
PIEZOMETER TYPE: Pneumatic operated SINCO Model No. 514178

NOTES:
1. Piezometer leads protected by 4 foot length, 5-inch diameter, Sch 40 PVC casing at the ground surface.
2. Piezometer tip set at 20.0 feet below the ground surface.
3. Drilling utilized 8-inch diameter hollow-stem augers.
4. Samples were recovered from depths of

NOTES - Continued
5. Soil descriptions were based upon visual identification of the auger spoil as well as the limited number of samples noted above.

NEYER, TISEO & HINDO, LTD.
CONSULTING ENGINEERS

PIEZOMETER No. 10-3

ALLEN PARK CLAY MINE LANDFILL
ALLEN PARK, MICHIGAN

APPROVED BY: [illegible] DATE: 3-11-85

NEYER, TISEO & HINDO, LTD. EXHIBIT I

30999 Ten Mile Road • Farmington Hills, MI 48024 • (313) 471-0750
2053 South Dort Highway • Flint, MI 48503 • (313) 232-9652
2615 Comerica Building • Detroit, MI 48226 • (313) 965-0036

JOB Allen Park Clay Mine PROJECT NO. 84185 SHEET NO. 2/12
SUBJECT Leachate Collection System BY WRB DATE 5/30/84
CHK. BY LJS DATE 6/28/84

Alternative Water Balance - Intermediate Cover

Assume 40% of precipitation evaporates each year (Fenn, et al., 1975) because of bare soil - no vegetation to assist evapotranspiration.

Month	J	F	M	A	M	J	J	A	S	O	N	D	Totals
P	53	54	62	68	85	84	79	71	68	62	59	57	803 mm
C_{SRO}	0.3	.3	.3	.28	.27	.25	.2	.2	.25	.27	.28	.3	
SRO	16	16	19	19	23	21	16	14	17	17	17	17	212
Evap.	21	22	25	27	34	34	32	28	27	25	24	23	322
PERC	16	16	18	22	28	29	31	29	24	21	18	17	269 mm

Max. rate ≈ $31 \text{ mm}/31 \text{ days} = 1 \text{ mm/day}$

Max rate from previous water balance $= 38 \text{ mm}/28 \text{ days} = 1.36 \text{ mm/day}$

Use FS = 1.5 → $q_{design} = 1.5 \times 1.36 = 2.0 \text{ mm/day}$

$$q_{design} = 2.0 \text{ mm/day} \left(\frac{\text{cm}}{10 \text{ mm}}\right)\left(\frac{\text{day}}{24 \text{ hr}}\right)\left(\frac{\text{hr}}{3600 \text{ sec}}\right) = 2.3 \times 10^{-6} \text{ cm/sec}$$

Check upward flow from aquifer into cell -

$K_{ave} \approx 2.6 \times 10^{-8} \text{ cm/sec}$ $\quad i = \frac{604-555}{555-521} = 1.4$

$q_{upward} \approx 2.6 \times 10^{-8} \text{ cm/sec} (1.4) = 3.7 \times 10^{-8} \text{ cm/sec}$

This is less than 2% of q_{design} → Negligible

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

December 5, 1984

TO: Al Howard

FROM: Terry McNiel Terry

SUBJECT: Ford-Allen Park Piezometer Proposal

I am in receipt of a recent submission by Mr. David Miller in which it is proposed to modify a previously agreed upon investigation to verify an assumed upward flow gradient in the site clay. An earlier proposal by Neyer, Tiseo and Hindo dated October 22, 1984 was submitted and approved on the basis of it meeting the scope of work (3 piezometer nests with 3 piezometers each) needed to adequately confirm the pressure gradient in the clay. This plan would allow a flow net to be developed to show vertical and lateral pressures and flows.

The modified plan describes 3 piezometers placed at 3 different locations at 3 different depths on three sides of cell 2. It does not provide the proof of the flow components and direction within the clay to fully evaluate the three-dimensional flow distribution as requested at the October 2, 1984 meeting. This "flow net" would then provide adequate detail and basis for a waiver to groundwater monitoring. One of the characteristic features of the diffusion process is that it causes spreading of the "solute", if the opportunity is available, in directions transverse to the flow path as well as the longitudinal flow direction. This is why we requested this evaluation with the nested piezometers. Because of the assumed variation in the bedrock surface and thickness of the confined sand unit, the data from the location of these piezometers may or may not truly reflect the vertical pressure distribution. Additionally, paragraph 3 of the 10/22/84 NT & H proposal states "the past and present excavation activities on the site have inevitably affected natural hydraulic gradients on a very localized basis ... it will be desirable to place these new installations (piezometer nests) as far as practicable from the on-site excavations in order to evaluate the natural hydraulic gradients." It is agreed that the natural unaffected hydraulic gradient may not be reflected near the excavation of Cells 1 and 2. Therefore, the modified location change is not acceptable.

The modified program was developed to evaluate: 1) basal stability due to uplift; 2) settlement; 3) bearing capacity; and 4) a preliminary slope stability analysis. It appears that these analyses can be accomplished by this plan, however, as a demonstration of the vertical and possibly lateral flow characteristics it is unacceptable. It is my recommendation

that a waiver to groundwater monitoring not be granted unless Ford adequately demonstrates the validity of the upward gradient assumption by means of the previously agreed upon plan.

cc: Burda/Quackenbush
Okwumabua/Aubuchon
D. Montgomery
C. Riley
C&E File

October 11, 1984

Mr. David Miller
Ford Motor Company - Steel Division
P.O. Box 1639
Dearborn, Michigan 48121

Dear Mr. Miller:

This letter is to summarize the October 2, 1984 meeting held at the Detroit district office between Ford, your consultant, and members of this department.

Compatibility testing between the natural clay liner and the site leachate is needed. The department recommends the use of leachate from Wayne Disposal Inc. for this testing since it would substantially reduce or eliminate the need for further testing of this type in the event that you seek approval to take additional waste types in the future. It was agreed that this testing will utilize a flexible wall parameter. The leachate must be tested to determine whether it contains the concentrations of chemicals in the leachate found now at your site plus those anticipated in the future. If it doesn't, the Wayne Disposal leachate used for the test will have to be modified by adding the necessary additional compounds. The impact of the Wayne Disposal leachate, modified as necessary, will be compared to similar testing using water.

Your consultant has provided theoretical calculations which indicate that it is impossible for contaminants to pollute the artesian aquifer which underlies the site. These calculations have assumed an upward gradient throughout the site's clay unit. It was agreed that this assumption will be examined by the use of site specific data. Three piezometer nests, each containing a minimum of three piezometers, will be installed within this unit to measure the distribution of the pressure head from the artesian aquifer. A flow net will then be constructed from this data which will substantiate or refute this assumption. Should this assumption be shown to be correct, groundwater monitoring will be focused on the shallow, surficial sand aquifer.

The shallow, surficial sand aquifer apparently only exists along the eastern end of the hazardous waste cells. It was agreed that monitoring of this aquifer is needed. However, due to the potential problem of possible recharge of the unit by the external drainage ditch, installation of a vertical detection system (sand or gravel sandwiched between clay walls) was discussed. A well can then be placed within the sandwiched permeable material for performance monitoring. Because wastes are presently near the sand unit, the department requests that this system be constructed soon, so as to develop background data. You should contact us in the near future so that we can reach agreement on appropriate design concepts. Once agreement is reached, you would be expected to prepare detailed engineering plans for our review and approval.

There was discussion of whether a gas venting system will be needed upon placement of the final cover. It was agreed that a system would not be required at this time. However, if significant gas generation is ever noted or if a change in the types of waste received ever suggests gas generation would be likely to occur, a venting system will be required.

Because of the need for you to satisfy RCRA Part B requirements in addition to MDNR requirements, it was agreed that we would meet with you at your request in the near future and discuss your proposals.

Sincerely,

TJMc

Terrance J. McNiel, Geologist
Technical Services Section
Hazardous Waste Division
517-373-2730

tkr

cc: J. Bohunsky/C & E File
Okwumabua/Aubuchon
A. Howard, HWD
J. Amber, Ford - SSECOS
C. Riley, HWD

November 14, 1984

Mr. David S. Miller
Mining Properties Department
Rouge Steel Company
3001 Miller Road
Dearborn, Michigan 48121

Dear Mr. Miller:

I have reviewed the October 22, 1984, proposal by Neyer, Tiseo and Hindo, Ltd. regarding the installation of three piezometer nests, each containing three piezometers. The proposal meets the objectives of the previously agreed upon study.

We look forward to seeing the conclusions reached by this investigation.

Sincerely,

TMc

Terrance J. McNeil, Geologist
Technical Services Section
Hazardous Waste Division
(517) 3732730

cc: B. Okwumabua/L. Aubuchon
J. Bohunsky/C & E File
D. Montgomery

JULY 1983 REPORT

CONTAINMENT INTEGRITY OF ALLEN PA[RK]
CLAY MINE / LANDFILL

1704 Morton Street
Ann Arbor, Michigan
48104

25 September 1983

Mr. Mark Young
Wayne Disposal Company
P.O. Box 5187
Dearborn, MI 48128

RE: Allen Park Clay Mine/Landfill

Dear Mark:

I recently wrote a computer program (*CLAYWALL*) that can be used to calculate solute transport across a clay barrier under combined diffusion and advection (hydraulic flow). The program computes the exit/source concentration ratio (C/Co) as a function of elapsed time (t) on the downstream side of a clay wall or barrier of thickness (X).

The program was written with a clay slurry cut-off wall in mind, but is general enough that it can be used with any clay layer or barrier. The input parameters to the program are:

D_e = efffective diffusion coefficient, ft^2/yr
K = hydraulic permeability, ft/yr
X = thickness of wall or barrier, ft
P = porosity
I = hydraulic gradient...(+) if same direction, (-) if opposite direction to solute concentration gradient
t = elapsed time, yrs

The program is based on the solution to the equation that describes one-dimensional solute transport in a saturated porous medium under both hydraulic and solute concentration gradients. This equation has the following form:

C/Co = 0.5[erfc((X-vt)/sqr(4DK)) + exp(vX/D) erfc((X+vt)/sqr(4DK))

where: v = ave seepage velocity = (KI/P)

The solution assumes the following conditions:

1. Saturated, one-dimensional flow.

2. No reaction between solutes and porous medium. Chloride typically behaves this way.

3. Diffusion controlled, i.e., the pore water velocity is so low that mechanical mixing is negligible and the dispersion is equal to the effective diffusion coeffficient. (this condition is satisfied when K< 1.0E-07.

I ran the program using data for the silty clay layer underlying the Allen Park ClayMine/Landfill. The following values for the input data were used:

D = 0.102 ft^2/yr (6.3E-06 cm^2/sec)
(published value for clay tills)
K = 0.025 ft/yr (2.5E-08 cm/sec)
X = 30 ft
P = 30 %
I = -0.1, -0.3, and -1.0

The results of the analysis are shown in the attached graph. At a counter hydraulic gradient of -0.3 the exit/source solute concentration ratio does not exceed 0.0001 until 700 years have elapsed. You may recall that a counter hydraulic gradient of -0.3 occurs when the leachate is allowed to rise in the landfill to the ground surface...a worst case scenario. For larger (negative) counter hydraulic gradients the ratios become even smaller. In fact for I< -0.5 (i.e., counter hydraulic gradients <u>larger</u> than 0.5) the ratio C/Co is less than 1.0E-05 at all elapsed times.

These results confirm the findings of my earlier report which were based largely on analogy to solute transport studies in clay aquitards. The present findings are based on analysis of actual soil and site parameters. Keep in mind, also, that the analysis is still quite conservative because it neglects possible adsorption (reaction) of solutes with the clay.

A copy of the computer program and typical output are enclosed. It is written in BASIC and is designed to be run on a personal computer. If you have any questions about the analysis, please feel free to contact me.

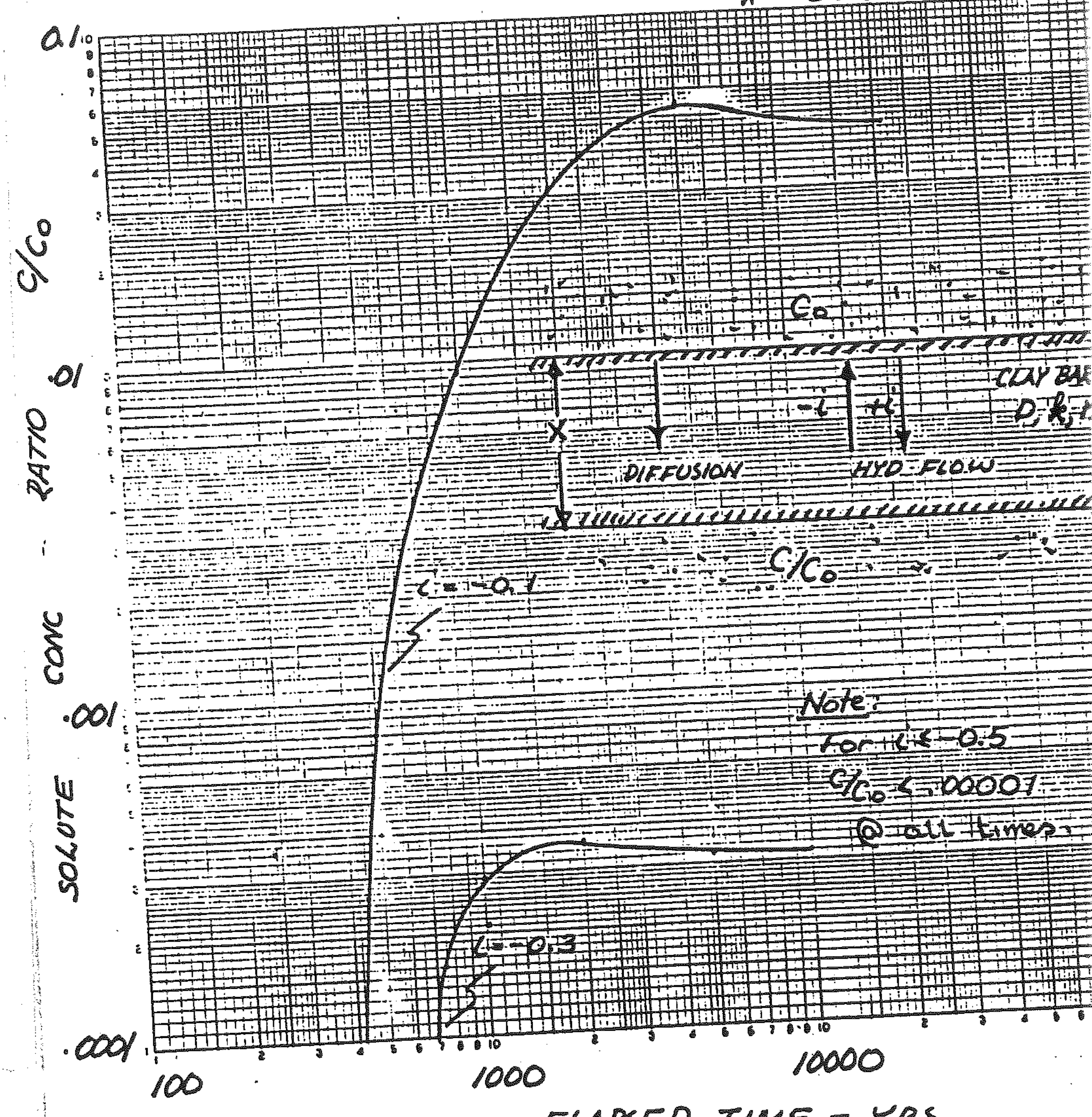
Sincerely,

Donald H. Gray

Donald H. Gray
Professor of Civil Engineering

Encl

D= 0.102 ft²/yr (3x10⁻⁶ cm²/s
k= 0.025 ft/yr (2.5x10⁻⁸ cm/s
n = 30 %
X = 30 ft.



```
run
Porosity: 0.3
Permeability(ft/yr): .025
Diffusion Coef(ft /yr): 0.102
Wall Thickness: 30
Hydraulic Gradient: -0.3
Time(yrs): 500
------------------------------------------------------------------
1st Argument(Y1)is:                              2.9756
1st Error Function is:                           0.9999
2nd Argument(Y2)is:                              1.22525
2nd Error Function is:                           0.9173
Exit/Source Concentration Ratio  (C/Co)is:                    8E-05
------------------------------------------------------------------
Continue Calculations (y/n) ? y

Time(yrs): 750
------------------------------------------------------------------
1st Argument(Y1)is:                              2.78685
1st Error Function is:                           0.99979
2nd Argument(Y2)is:                              0.64312
2nd Error Function is:                           0.63658
Exit/Source Concentration Ratio  (C/Co)is:                    2.2E-04
------------------------------------------------------------------
Continue Calculations (y/n) ? y

Time(yrs): 1000
------------------------------------------------------------------
1st Argument(Y1)is:                              2.72291
1st Error Function is:                           0.99973
2nd Argument(Y2)is:                              0.24754
2nd Error Function is:                           0.27399
Exit/Source Concentration Ratio  (C/Co)is:                    3.7E-04
------------------------------------------------------------------
Continue Calculations (y/n) ? y

Time(yrs): 2000
------------------------------------------------------------------
1st Argument(Y1)is:                              2.80056
1st Error Function is:                           0.9998
2nd Argument(Y2)is:                              -0.70014
2nd Error Function is:                           0
Exit/Source Concentration Ratio  (C/Co)is:                    4.2E-0
------------------------------------------------------------------
Continue Calculations (y/n) ? y

Time(yrs): 5000
------------------------------------------------------------------
1st Argument(Y1)is:                              3.43176
1st Error Function is:                           0.99998
2nd Argument(Y2)is:                              -2.10334
2nd Error Function is:                           0
Exit/Source Concentration Ratio  (C/Co)is:                    3.3E-
------------------------------------------------------------------
Continue Calculations (y/n) ? n
```

Report Prepared for:

Wayne Disposal, Inc.

CONTAINMENT INTEGRITY OF ALLEN PARK CLAY MINE/LANDFILL

by

Donald H. Gray
Professor of Civil Engineering
The University of Michigan

Ann Arbor, Michigan

July 1983

SUMMARY

The possibility of leachate migration downward from the Allen Park Clay Mine/Landfill and contamination of an aquifer beneath were evaluated.

Analyses show that density differences between the leachate and groundwater will not cause a downward migration nor will they lead to a diffusion efflux from the site. A thick, uniform layer of silty clay beneath the site coupled with an upward hydraulic gradient effectively precludes the latter.

Comparison with results of salt water intrusion studies across clay aquitards having similar properties as the clay beneath the Allen Park site show that the solute (salt) will take at least 800 years to migrate across a clay barrier 30 feet thick under chemico-osmotic diffusion alone. A counter (or upward) hydraulic gradient will lengthen this breakthrough time even further.

There are insufficient amounts of organic compounds in the waste to affect the permeability of the clay. The probability of accelerated leachate migration through the underlying clay is not supported by the composition of the wastes and the nature of the clay nor by the findings of leachate permeability studies reported in the technical literature.

Under these circumstances any observed increases in contaminant levels of monitor wells in the aquifer underlying the site could more reasonably come from sources laterally upgradient from the site rather than the clay mine/landfill above the site.

TABLE OF CONTENTS

CONTAINMENT INTEGRITY OF ALLEN PARK CLAY MINE/LANDFILL

I. INTRODUCTION

The Ford Motor Company who operate the Allen Park Clay Mine/Landfill have recently petitioned to discontinue ground water monitoring of an aquifer located approximately 70 feet below existing grade at the site. The landfill is underlain by dense, lacustrine clay which behaves as an aquiclude or aquitard. At least 25 feet or more of residual clay thickness separates the bottom of the landfill from the underlying aquifer. The aquifer is under artesian pressure and exerts an upward hydrostatic pressure on the base of the clay aquitard equivalent to 80 feet of head. A general cross section or profile illustating these soil and hydrologic conditions at the site is shown in Figure 1.

Applicant maintains in his petition for discontinuance (EPA I.D. No. MIT 980568711) that monitoring is not necessary at the site because of a) the dense, uniform clay underlying the site which has a hydraulic permeability no greater than 6×10^{-8} cm/sec and b) the artesian pressure in the underlying aquifer which results in an upward hydraulic gradient across the overlying clay aquitard. Applicant claims that these site conditions will preclude the possibility of leachate migrating downwards out of the landfill and eventually contaminating the aquifer.

In response to this petition, the Wayne County Department of Public Health has raised several questions and concerns (letter form R.N. Ratz, Public Health Engineer, to B. Trethewey, Mining Properties Department, Ford Motor Company, 28 April 1983). The following concerns were raised in the letter:

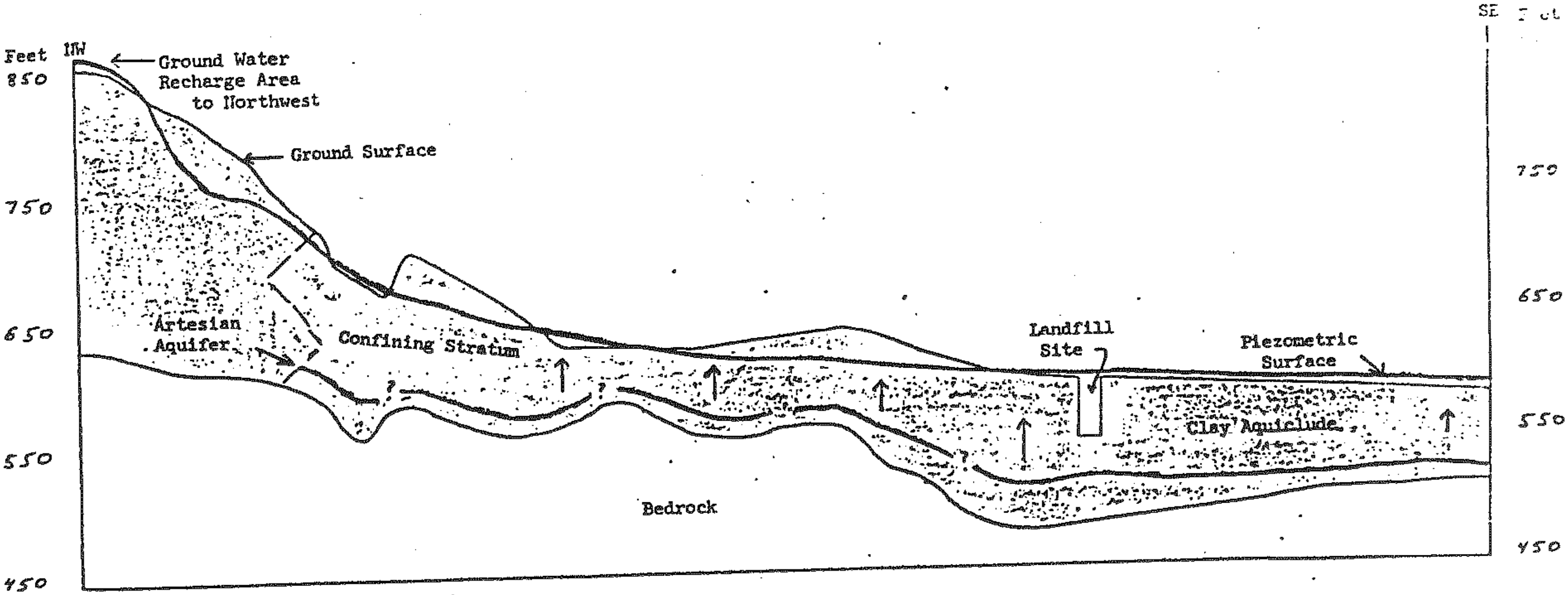
1. The petition/report fails to address the possibility of leachate migrating down due to differences in densities of the leachate and groundwater.

2. The petition/report does not indicate if there are any organic constituents in the leachate that may increase the clay's permeability and permit downward movement.

The purpose of the present report is to respond to the above stated concerns. Additional information about the geohydrology of the site, about past containment/migration studies, and about the likely nature of the leachate and its effect on clay permeability are evaluated herein to determine the danger of landfill leachate migrating downwards from the site and reaching the underlying aquifer.

NW - SE GENERALIZED CROSS SECTION

METROPOLITAN DETROIT AREA (ERIE - ST. CLAIR PLAIN)



SCALE

Vertical 1" = 100 Feet
Horizontal 1" = 2 Miles

Reference Map

USGS - Mich. Detroit District
Geology by W. H. Sherzer

Figure 1. Generalized cross-section through Allen Park Clay Mine/Landfill showing soil and hydrologic conditions.

II. THE INFLUENCE OF PERMEANT DENSITY ON LEACHATE MIGRATION ACROSS CLAY BARRIERS

A. GENERAL

Permeant density plays a direct and indirect role in flow phenomena in porous media. Permeant density can affect solvent or solution flow rates via its influence on hydraulic conductivity. This influence can be calculated and shown to be minor or insignificant compared to the more likely and important influence of permeant density on solute diffusion.

A newly introduced permeant with a high concentration of dissolved material (e.g., a leachate) will also have a higher density. This high concentration in turn will cause the solute to diffuse through a porous medium to regions of lower concentration. It is this manifestation or aspect of a density increase in the permeant that requires careful scrutiny and analysis. In other words, the role and influence of permeant density are more important to solute diffusion under concentration gradients as opposed to solvent (or solution) convection under hydraulic gradients.

The analyses that follow are offered in support of these claims.

B. INFLUENCE OF PERMEANT DENSITY INCREASE ON HYDRAULIC PERMEABILITY

Both the viscosity and unit weight of a permeant can influence the permeability of a soil to a particular permeant. The hydraulic conductivity is defined in this case as a flow velocity under a unit hydraulic gradient (the usual practice in civil engineering). The influence of permeant density and viscosity can be ascertained explicitly by defining another permeability, i.e., the "intrinsic" or "absolute" permeability

$$K = \frac{k\,\mu}{\gamma} \qquad (1)$$

where:
k = hydraulic conductivity, cm/sec
K = intrinsic or absolute permeability, cm^2
γ = permeant density or unit weight, $dynes/cm^3$
μ = permeant viscosity, poise

The intrinsic permeability(K) is a property only of the solids or matrix through which the permeant passes. Accordingly, for a particular soil (i.e., given grain size distribution and soil structure) and in the absence of permeant-soil reactions, K should be a constant. The influence of a variation in viscosity and density of the permeant on the hydraulic conductivity can be determined from this fact and from a relationship derived from Equation 1, viz.,

$$k_2 = k_1 (\gamma_2/\gamma_1)\ (\mu_1/\mu_2) \qquad (2)$$

where: subscript 1 - initial conditions (grnd water)
subscript 2 - final conditions (leachate)

An increase in density of the permeant will apparently cause a higher permeability. But, this same increase in density can also result in an increase in viscosity which will reduce the permeability. Both influences together will tend to offset one another, and it is unlikely that a density increase in the permeant (leachate) will significantly affect hydraulic conductivity. Furthermore, even if viscous retardation is discounted, density increases are highly unlikely to significantly increase permeability in actual practice as the following example will show.

Assume the ground above an aquitard or clay barrier is flooded with a fairly concentrated brine solution, namely sea water. The density of sea water (with a TDS of 36,000 ppm) is 1.036 gm/cc at 4° C vs. the density of the present interstitial water (with an average TDS of 1550 ppm) which is 1.002 gm/cc. This leads to a density ratio of 1.034 which is equivalent to only a 3.4 per cent increase in hydraulic conductivity (discounting viscous retardation). Therefore, density has little effect on hydraulic conductivity despite the almost 20 fold increase in dissolved solids concentration. It is the influence of the latter change, i.e., the increase in dissolved solids concentration, that requires careful analysis in evaluating the effectiveness of a clay barrier in containing leachate migration in this case.

C. INFLUENCE OF PERMEANT DENSITY INCREASE ON SOLUTE DIFFUSION

1. Background

Dissolved solids or solutes in a permeant can be transported through soils under both hydraulic and concentration gradients. The former is referred to as "drag coupling" and the latter as "chemico-osmotic diffusion." Both types of movement should be considered when evaluating the effectiveness of a clay barrier for preventing leachate migration.

Chemico-osmotic effects in fine grained soils have been examined in some detail by Olsen (1969) and Mitchell et al.(1973). The importance of chemico-osmotic diffusion increases in fine grained soils wilth low hydraulic conductivities. Studies commissioned by the State of California(1971) on salt intrusion problems in aquifer-aquitard systems have shown that as aquitards become clay rich and their permeabilities fall to levels on the order of .002 gpd/ft^2 or 10^{-7} cm/sec, the migration of solutes will be controlled by chemico-osmotic diffusion.

2. Flow of Solute under Combined Hydr. and Chem. Gradients

Equations can be derived which describe the flows of solute and solution in the pores of a sediment. The derivation of these equations and assumptions on which they are based are given by Mitchell et al.(1973). The one-dimensional, vertical, steady state flux of solute across a clay aquitard under a combined salt concentration(chemical) gradient and hydraulic gradient is given by the following relationship:

$$J_s = [(\gamma_w/TR)c_s k_{ch} + c_s k_h] \partial h/\partial z + [D + c_s k_{ch}] \partial c_s/\partial z \quad (3)$$

where: J_s = salt flux across an aquitard, moles/sec/cm^2
$\partial h/\partial z$ = hydraulic gradient (dimensionless)
$\partial c_s/\partial z$ = solute concentration gradient, moles/cm^4
D = diffusion constant, cm^2/sec
R = gas constant, ergs/mole/°K
γ_w = density of water, dynes/cc
T = absolute temperature, °K
c_s = average salt concentration, moles/cc
k_h = hydraulic conductivity, cm/sec
k_{ch} = chemico-osmotic coupling coefficient, cm^5/mole/sec

Relative contributions to the salt or solute flux can be calculated from Equation 3. Movement of solute can occur by diffusion whether a hydraulic gradient is present or not. A superposed hydraulic gradient may retard or accelerate movement of solute depending on:

a) Relative magnitude and direction of the hydraulic and solute concentration gradients.

b) Values of the hydraulic conductivity and chemico-osmotic coupling coefficient.

Equation 3 only yields the steady state flux of solute under combined hydraulic and chemical gradients. Equations can also be derived that give the initial or time dependent solute fluxes and the time required for "breakthrough" or first appearance of increased solute concentration on the downstream side of the aquitard. This initial, non-steady state process is quite complicated. Examples have been worked out for aquitards of different thicknesses and composition by Mitchell et al.(1973).

One of the most important findings of these studies on salt flux across clay aquitards was the importance of aquitard thickness on breakthrough time. Because the initial movement is non-steady, the breakthrough time increases with the square of the thickness of the aquitard. Theoretical studies of salt water intrusion across aquitards (State of California, 1971) have shown that salt ions will

take up to 800 years to migrate across an aquitard 30 feet thick under chemico-osmotic diffusion alone. If the thickness is reduced to 10 feet, the breakthrough time decreases to only 80 years. The presence of an hydraulic gradient could either accelerate or retard this time depending on the relative magnitude and direction of this gradient and other factors cited previously (see Figure 3).

3. Likelihood of Solute Efflux Through Clay at Allen Park Site

Solutes will tend to migrate or diffuse downward from the landfill along a concentration gradient. On the other hand, this movement can be impeded or even arrested by the upward hydraulic gradient as a result of artesian pressure in the underlying aquifer. Static water levels in monitor wells around the landfill show that the piezometric surface is almost 10 feet above existing grade or ground surface elevation at the site (see Table 1). The net, steady state flux of solute, if any, can be determined under these conditions from the solute flow equation cited previously (Equation 3).

It is also pertinent to examine the results of a similar type of study commissioned by the State of California (1971). The latter study was designed to determine salt efflux rates and breakthrough times in an aquitard-aquifer system in the coastal ground water basin near Oxnard, California (see Figure 2). The problem posed in the California study was basically the same as the pre-sent one; namely, given a sudden increase in dissolved solids or solute concentration atop a clay barrier (or aquitard) how long before the salt migrated downward and reached an underlying aquifer and at what rates of efflux? The problem was compounded in the California example as a result of drawdown of the piezometric surface in the underlying aquifer which also caused a downward hydraulic gradient.

The two aquitards are quite similar in their important respects. Both are approximately the same thickness, have the same initial dissolved solids concentration, and are composed of clayey sediments with low hydraulic conductivities. The salient charateristics and parameters of these two aquitards are summarized and compared in Table 2. The main difference appears to be in their respective hydraulic conductivities-- the Allen Park clay is an order-of-magnitude lower.

A dissolved solids concentration equal to that of sea water was assumed in the leachate overlying the Allen Park clay. Sea water is a good "worst case" choice because sodium ions have high diffusion mobilities and are not preferentially adsorbed on clay exchange sites as heavy

TABLE 1. ALLEN PARK CLAY MINE

MONITOR WELL - WATER LEVEL READINGS

Well Number	Ground Elevation, Ft.	Well Elevation[(1)] USGS	Ground Water[(2)] Elevation 11-4-81	Δ	Ground Water[(3)] Elevation 5-29-81	Ground Water[(3)] Elevation 3-26-81
2	595.1	600.76	600.67	5.6	600.44	600.21
5	595.7	605.92	605.09	9.4	604.62	604.49
7	594.1	597.35	591.01	-3.1	593.23	594.14
10	593.4	603.03	601.81	8.4	601.93	601.56
W-101	593.9	601.47	601.21	7.3		
W-102	591.3	600.81	603.22[(4)]	11.9		
W-103	593.9	605.06	603.52	9.6		
W-104	594.1	603.82	603.81	9.6		
W-105	594.5	604.08	603.86	9.4		

$\Delta_{av} = 8.9$

(1) Well Elevation is recorded as top of standpipe.

(2) Data Recorded by Michigan Testing Engineers, Inc.

(3) Data obtained from Michigan Department of Natural Resources.

(4) Well extended temporarily to obtain water level.

TABLE 2. COMPARISON OF AQUITARD PROPERTIES AND SITE PARAMETERS

AQUITARD PROPERTY OR SITE PARAMETER	OXNARD CALIFORNIA	ALLEN PARK MICHIGAN
Composition	clayey silt & silty clays	silty clay
Thickness, ft	30	25 - 35
Ave. Water Content, %	24	20
Ave. Liquid Limit, %	31	28
Ave. Hydraulic Conduct, cm/sec	1×10^{-7}	2.6×10^{-8}
Hydraulic Gradient	0.33 - 1.0 (downward)	2.7 (upward)
Initial (interstitial) Pore Water Solute Conc, ppm	1800	1550
Final Solute Conc, ppm	36,000	36,000 (assumed)
Chemico-Osmotic Coupling Coefficient, cm^5/mole/sec	6.2×10^{-4}	6.2×10^{-4}

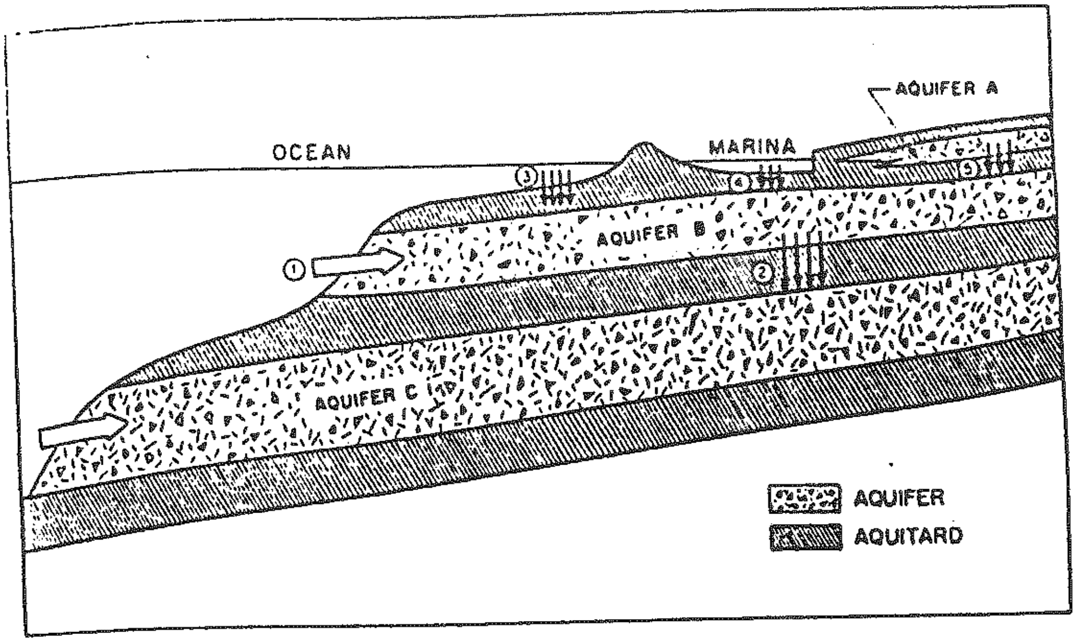


Figure 2. Generalized cross-section of multiple aquifer in a coastal basin. Salt flux across aquitard can occur as result of either salt water intrusion into aquifer (1,2) or salt water entering directly above aquitard in shallow coastal waters or marinas (3,4), or from salt contamination in near surface, perched aquifer (5).

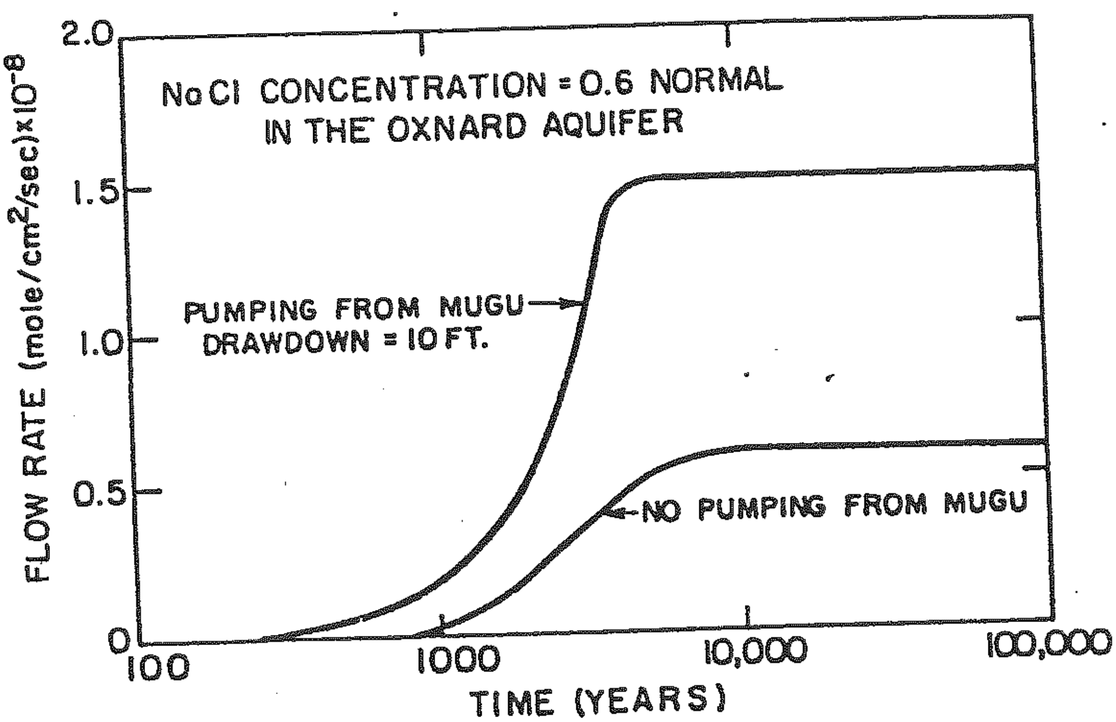


Figure 3. Solute efflux across aquitard into underlying aquifer as a result of salt water intrusion in overlying aquifer. Aquitard is 30 feet thick and has a hydraulic conductivity of 10^{-7} cm/sec. Pumping from lower (Mugu) aquifer superposes a 0.33 downward gradient on system.

metal ions would tend to be. The same chemico-osmotic coupling coefficient used in the California aquitard was also assumed applicable for the Allen Park clay. The value used is reasonable for the type of clay sediments present.

Results of the California study are presented in Figure 3 which shows the salt influx into the underlying aquifer as a function of time. Curves are presented for a no drawdown and 10-foot drawdown case (assuming the hydraulic gradient acts in the same direction as the salt concentration gradient). The horizontal portion of the two curves represents the steady state salt flux.

The main things to notice from this figure are the large breakthrough time (800 years) for the "no drawdown" case (i.e., in the absence of any hydraulic gradients) and the fact that in this aquitard the salt flux caused by drag coupling under a hydraulic gradient is larger. The steady state salt flux from the drag coupling under a combined 10-foot drawdown and salt concentration gradient is almost three times that from diffusion alone (no drawdown). Hence, in the event the hydraulic gradient was reversed, there would be no breakthrough and no downward salt flux provided the upward gradient exceeded about 0.2. In other words, under these conditions the two salt fluxes would be mutally opposed and exactly counterbalanced.

The relative contributions to steady state efflux in this example can be calculated with the aid of Equation 3. The following parameter values (taken from the study) were used in the calculation:

$$\partial h / \partial z \approx \Delta h / \Delta L = 10/30 = 0.33$$

$$\partial c / \partial z \approx (c_{s_2} - c_{s_1}) / \Delta L = \frac{0.57 \times 10}{914} = 0.62 \times 10 \text{ moles/cm}^4$$

$$c_s = (c_{s_2} + c_{s_1}) / 2 = \frac{(0.60 - 0.03) \times 10}{2} = 0.32 \times 10 \text{ moles/cm}^3$$

$$D = 10^{-5} \text{ cm}^2\text{/sec}$$

$$R = 8.32 \times 10^7 \text{ ergs/mole/}^\circ\text{K}$$

$$T = 300\ ^\circ\text{K}$$

$$\gamma_w = 10^3 \text{ dynes/cc}$$

$$k_h = 10^{-7} \text{ cm/sec}$$

$$k_{ch} = 6.2 \times 10^{-4} \text{ cm}^5\text{/mole/sec}$$

Using these values the calculated contributions to steady state solute flux are respectively:

Drag Coupling: $J_{s_1} = [(\gamma_w/RT)c_s k_{ch} + c_s k_h] \partial h/\partial z$

$$= \left[\frac{10^3(2\times10^{-7})}{8.32\times10^7(.3\times10^{-3})} + 0.32\times10^{-3}(10^{-7})\right] 0.33$$

$$= 1.056 \times 10^{-11} \text{ moles/sec/cm}^2$$

$$= \underline{0.98 \times 10^{-8} \text{ moles/sec/ft}^2}$$

Chemico-Osmotic Diffusion:

$$J_{s_2} = [D + c_s k_{ch}] \partial c_s/\partial z$$

$$= [10^{-5} + 2\times10^{-7}] \, 0.62\times10^{-6}$$

$$= 0.63 \times 10^{-11} \text{ moles/sec/cm}^2$$

$$= \underline{0.58 \times 10^{-8} \text{ moles/sec/ft}^2}$$

The total salt flux is the sum of the contributions from drag coupling and chemico-osmotic diffusion or

$$J_s = J_{s_1} + J_{s_2}$$

$$= (0.98 + 0.58) \times10^{-8}$$

$$= \underline{1.56 \times 10^{-8} \text{ moles/sec/ft}^2}$$

These calculations are in agreement with the results shown in Figure 3 for steady state salt inflow under combined gradients. They also illustrate that the drag coupling contribution under a 10-foot drawdown (0.33 hydraulic gradient) exceeds the chemico-osmotic diffusion contribution.

In the case of the clay aquitard beneath the landfill at Allen Park, the average hydraulic conductivity is almost an order-of-magnitude lower (2.6×10^{-8} vs. 10^{-7} cm/sec). This will tend to decrease the drag coupling. On the other hand, this tendency will be more than offset by higher hydraulic gradients at this site. If the level of the leachate is kept at or close to the bottom of the landfill, then the gradient will approach 80/30 or 2.7. The drag coupling component of solute flux in this case will be

$$J_{s_1} = \left[\frac{10^3(2\times10^{-7})}{8.32\times10^7(.3\times10^{-3})} + 0.32\times10^{-3}(2.6\times10^{-8})\right] \times 2.7$$

$$= [0.008\times10^{-12} + 0.832\times10^{-11}] \times 2.7$$

$$= 2.25 \times 10^{-11} \text{ moles/sec/cm}^2$$

$$= \underline{2.09 \times 10^{-8} \text{ moles/sec/ft}}$$

This flux is greater than 3X the chemico-osmotic flux; and since it acts in the <u>opposite</u> direction, there will be no net downward flux of solute at the Allen Park site. The critical hydraulic gradient to maintain a zero net salt efflux is 0.8. This means that the groundwater table could rise to within 12 feet of present ground elevation (~595 ft) in the landfill and there would still be a sufficient upward hydraulic gradient (drag coupling effect) to completely counter solute efflux under chemico-osmotic diffusion (see summary below).

Position of Ground Water Table in the Landfill	Upward Hydraulic Gradient	Net, Steady State Solute Efflux Rate (moles/sec/ft^2)
At bottom	2.7	-1.51×10^{-8} (net influx)
12 feet from top	0.8	zero
At top	0.33	$+0.32 \times 10^{-8}$

These calculations are based on the existence of a static or piezometric head in the underlying aquifer approximately 9-10 feet above ground elevation (see Table 1).

Assumption of worst case conditions, namely, a rise in the groundwater table in the landfill to ground surface elevation, leads to a small, steady state efflux rate from chemico-osmotic diffusion. This occurs because the resulting hydraulic gradient (0.33) is no longer large enough to completely oppose the chemico-osmotic salt flux. The breakthrough times, however, would be so immense (1000's of years) that the steady state flux under these conditions is largely irrelevant.

It is important to note that the preceding calculations are also based on the following "worst case" assumptions:

1. A highly saline leachate with a concentration and composition equal to that of sea water.

2. No interaction between the solute and clay.

In actual practice, there would be some uptake and adsorption of solutes on the clay. This adsorption would attenuate or limit further solute concentrations in the leachate as it passed through the clay.

III. EFFECT OF LEACHATE CONSTITUENTS ON THE PERMEABILITY OF CLAY

A. GENERAL BACKGROUND

The possibility that leachate--either in the solvent or solute phase--might affect clay permeability and hence its containment integrity has been raised by a number of investigators (Anderson and Brown, 1981; Haxo, 1981; and Folkes, 1982). One of these studies has shown that concentrated organic liquids can increase clay permeability by several orders-of-magnitude (Anderson and Brown, 1981).

All of these studies were conducted in the laboratory with simulated leachates from particular types of wastes and under particular testing conditions. The danger of blindly applying these test results to a field situation have been noted recently by Gray and Stoll (1983). It is essential to ask the following before the results of these lab tests can be applied to a given field situation:

1. <u>What was the nature of the leachate in the lab tests?</u> What are the concentrations of various constituents in the leachate in the field as opposed to the lab tests? How relevant are the lab test results in the light of potentially large differences in leachate composition (lab vs. field)?

2. <u>How did the leachate contact or interact with the clay in the lab tests?</u> Was it forced through? If so, at what gradient? Is there any prospect that the leachate will be able to penetrate/permeate through the clay containment in the field in like manner? In other words are the necessary gradients and other conditions present to permit this to happen?

3. <u>What was the failure or clay degradation process by which the apparent permeability increase occured in the lab tests?</u> Was it by a) dissolution, b) syneresis, c) piping? Could these mechanisms reasonably occur in the field given the type, water content, and density of the in-situ clay plus the nature and concentration of organic and inorganic compounds in the leachate?

B. WASTE AND LEACHATE COMPOSITION AT THE ALLEN PARK CLAY MINE

The types, composition, and relative amounts of wastes placed in the Type II Solid Waste Landfill at Allen Park are shown in Tables 3 and 4. The results of typical E.P.T leachate tests on these wastes are shown in Table 5. The likely nature and composition of the landfill leachate can be estimated from this information. This estimate is adequate for purposes of evaluating the probable effect of the leachate on clay permeability.

TABLE 3. ALLEN PARK CLAY MINE - SOLID WASTE LANDFILL CONSTITUENTS

Fly Ash	-	50%
Blast Furnace Filter Cake	-	15%
Construction Debris - Sweepings - Clean-Up	-	14%
BOF Dust	-	6%
Foundry Sand	-	6%
Electric Furnace Dust	-	4.8%
Coal and Coke	-	3%
Coke Oven Decanter Tar Sludge	-	0.6%
Glass	-	0.5%
Wood Ash	-	0.5%
BOF Kish	-	0.3%
Wastewater Treatment Sludge	-	0.2%
Grinding Mud	-	0.1%

TABLE 4. ALLEN PARK CLAY MINE WASTES. TYPICAL AS RECEIVED ANALYSES (mg/kgm).

	Decanter Tank Tar Sludge	Electric Arc Furn. Dust	Blast Furn. Flue Dust	BOF Flue Dust	Blast Furn. Filter Cake	Foundry Sand	BOF Kish	Fly Ash	Lime Dust	Coke Breeze
EP Toxic	No	Yes(Zn,Pb,Cd)	No	No	No	No	No	Exempt	No	
Iron	----	350,000	122,000	560,000	150,000	1,200	490,000	34,500	----	[illegible],800
Carbon	----	4,700	520,000	7,400	404,000	6,600	240,000	194,000	----	[illegible]0,000
Arsenic	----	50	19	42	2	20	78	----	----	10
Barium	----	<1	<1	<1	20	<1	<1	----	----	<1
Cadmium	----	95	<1	50	8	<1	<1	----	----	<1
Chromium	----	500	<1	130	70	<1	60	----	----	1
Lead	----	<4,500	<1	3,000	350	44	<1	----	----	69
Mercury	----	<1	<1	<1	<1	<1	<1	----	----	<1
Selenium	----	120	98	<1	<1	35	70	----	----	[illegible]
Silver	----	6	<1	<1	9	<1	<1	----	----	15
Manganese	----	39,000	7,500	10,000	4,500	79	2,800	----	----	70
Zinc	----	150,000	120	22,000	400	40	194	----	----	110
Phosphorus	----	450	200	190	300	400	170	----	----	59
Sulfur	----	3,600	4,000	1,600	4,000	200	850	3,100	----	7,300
Calcium	----	61,000	18,000	2,000	20,000	60	580	13,100	714,700	[illegible]
Magnesium	----	11,000	7,500	9,600	13,000	100	3,800	5,400	----	300
Aluminum	----	2,400	2,200	<2	3,700	<2	1,600	147,200	----	<2
Silicon	----	15,000	28,000	8,000	83,000	450,000	25,000	201,700	----	20,000
Potassium	----	5,900	980	5,000	2,200	170	640	9,700	----	220
Sodium	----	5,200	440	2,300	1,500	390	630	3,700	----	[illegible]
Fluorine	----	26	10	23	4	<1	48	----	----	<1
Cyanide	14	<1	<1	<1	3	<1	<1	----	----	2
Phenol	1,800	<1	<1	<1	3	<1	2	----	----	3
Naphthalene	2,700	----	----	----	----	----	----	----	----	----

TABLE 5. ALLEN PARK CLAY MINE SOLID WASTES TYPICAL E.P.T. LEACHATE TEST RESULTS (Mg/1)

Parameter	Blast Furnace Flue Dust	BOF Flue Dust	Blast Furnace Filter Cake	Foundry Sand	BOF Kish	Coke Breeze	Wastewater Treatment Sludge
Arsenic	0.04	0.02	< 0.1	0.03	0.1	< 0.1	.00[illegible]
Barium	< 0.8	< 0.04	< 0.8	< 0.08	< 0.8	< 0.8	.45
Cadmium	0.01	0.03	< 0.08	< 0.005	< 0.005	< 0.005	.005
Chromium	< 0.1	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	.101
Lead	< 0.2	1.7	1.7	< 0.2	< 0.2	< 0.2	.0[illegible]5
Mercury	0.0007	< 0.01	< 0.2	< 0.2	< 0.2	< 0.2	.000[illegible]
Selenium	1.0	< 0.01	< 0.[illegible]	0.10	0.4	< 0.5	[illegible]
Silver	< 0.1	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	.00[illegible]

Compiled By [illegible]
March 1, 19[illegible]

The data in Tables 3 and 4 indicate that 50 per cent of the solid waste consists of relatively inert fly ash and that some 89 per cent of the wastes consist of materials that do not contain significant amounts of heavy metals (Zn, Pb, Cd) or organics known or suspected to be toxic such phenol and naphthalene (see Table 4). The coke oven decanter tar sludge is a possible source of organics (phenol and napthalene), but this waste comprises only 0.6 per cent of the total stream in the Type II Solid Waste landfill.

C. PROBABILITY OF ORGANICS IN LEACHATE AFFECTING CLAY PERMEABILITY AT ALLEN PARK SITE

Anderson and Brown (1981) found that several organic liquids, viz., aniline, acetone, ethylene glycol, heptane, and xylene, cause large increases in permeability of four compacted clay soils. Pure organic liquids were used in their study. One of the authors (Anderson, 1982) later emphasized that their results cannot be used to support claims that clay liners permeated by dilute organic liquids may be susceptible to large permeability increases.

Haxo (1981) reported results of up to 52 months of liner exposure to selected industrial wastes. He included several organic wastes, namely, aromatic oil, Oil pond 104, and a pesticide. The results of large permeameter tests on a compacted fine-grained soil and admixed materials are summarized in Table 6. Although a small amount of seepage passed through the compacted, fine-grained soil liner, no permeability increases were reported with any of the organic wastes.

On the basis of these studies and with the caveats noted at the beginning of this section in mind, it is possible to evaluate the likely effect of the landfill leachate on clay permeability at the Allen Park site.

1. Type II Solid Waste Landfill

As noted previously the existing landfill contains small quantities of coke oven decanter tar sludge which is a possible source of organics (phenol and naphthalene), but this waste comprises only 0.6 per cent of the total. Phenol and naphthalene are present in the tar component of this waste in concentrations estimated by Desha (1946) of 0.1 and 2.2 per cent by weight respectively. Accordingly, the amount of phenol and naphthalene present in the total waste stream are .006 and .013 per cent by weight respectively. These amounts constitute a very low fraction and they suggest that leachate from the total waste stream will tend to have very low concentrations of phenol and napthalene. Therefore, the organics in the leachate from the Type II Solid Waste landfill are quite unlikely to affect clay permeability.

TABLE 6. EFFECTS OF INDUSTRIAL WASTES ON SOIL AND ADMIX LINERS (from Haxo, 1981)

Liner material	Acidic waste (HNO_3, HF, HOAC)	Alkaline waste (spent caustic)	Lead (low lead gas washing)	Oily waste: Aromatic oil	Oily waste: Oil pond 104	Pesticide (weed killer)
Compacted fine-grained soil 305 mm thick	Not tested	Measurable rate of seepage $v_s = 10^{-10}-10^{-9}$ m/s, waste penetrated 3–5 cm after 30 months (*a*)		$k=1.8\times10^{-10}$ $k=2.4\times10^{-10}$ $k=2.6\times10^{-10}$ (tests on soil after 30 months)	†	†
Soil cement 100 mm thick	Not tested	No measurable seepage after 30 months				
Modified bentonite and sand (2 types) 127 mm thick	Not tested	Measurable seepage after 30 months, channelling of waste into bentonite (*b*)			Failed (waste seepage through liner)	‡
Hydraulic asphalt concrete 64 mm thick	Failed	Satisfactory	Waste stains below liner asphalt mushy	Not tested	Not tested	Satisfactory
Spray-on asphalt and fabric 8 mm thick	Not tested	Satisfactory	Waste stains below liner	Not tested	Not tested	Satisfactory

*From data presented by Haxo (1981).
†Same as (*a*).
‡Same as (*b*).

2. Type I Hazardous Waste Landfill

In the future the decanter tar sludge will be placed in a separate landfill that will be upgraded to accept hazardous wastes. This action will increase the relative proportion of organics (phenol and naphthalene) in the waste stream. Leachate tests run on pure samples of decanter tar sludge using a distilled water extraction procedure (Calspan, 1977) have produced phenol concentrations of approximately 500 ppm. Even this concentration is far removed from the very high concentrations of organic solvents used by Anderson and Brown (1981) in their permeability tests on different clays. Accordingly, organics in the leachate from the Type I Hazardous Waste landfill are also unlikely to affect clay permeability.

In summary: It does not appear likely nor reasonable that organics present in the wastes at the Allen Park Clay Mine/Landfill will cause a permeability increase given their low concentration and the absence of any substantiation in the published technical literature for such an increase under these conditions.

IV. CONCLUSIONS

(1). There appears to be very little likelihood of leachate migrating downward from the Allen Park Clay Mine/Landfill and contaminating the aquifer beneath the clay.

(2). A density difference between the leachate and groundwater will have little or no influence on hydraulic permeability or downward migration nor will it lead to diffusion efflux of solutes. A thick, uniform bed of silty clay beneath the site coupled with an upward hydraulic gradient precludes the latter. Calculations and analyses are provided herein to support this finding.

(3). Comparison with results of salt water intrusion studies across clay aquitards having similar properties as the clay beneath the Allen Park Clay Mine site show that the solute (salt) will take at least 800 years to migrate across a clay barrier 30 feet thick under chemico-osmotic gradients alone. A counter (or upward) hydraulic gradient will increase this breakthrough time even more.

(4). The waste and its leachate are unlikely to increase the permeability of the underlying clay. This claim is reasonable in view of the low concentrations of organics in the total waste stream and in the light of the findings and caveats of permeability/exposure tests with organic permeants reported in the technical literature. This conclusion applies to both the existing Type II Solid Waste landfill and a proposed Type I Hazardous Waste landfill that will accept the coke oven decanter tar sludge.

(5). The composition of the waste and underlying clay do not suggest properties or combination of properties that could lead to a containment failure caused by such processes as piping, acid/base dissolution, or syneresis.

(6). Under these circumstances any observed increase in contaminant levels of monitor wells in the aquifer underlying the site could just as well come from other sources laterally upgradient from the site rather than from the clay mine/landfill above the site.

(7). These findings and conclusions support the basis of applicant's petition for discontinuing further monitoring of the wells penetrating the aquifer beneath the site.

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